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Printing Post Office Money Orders.

By Thomas D. Gannaway.

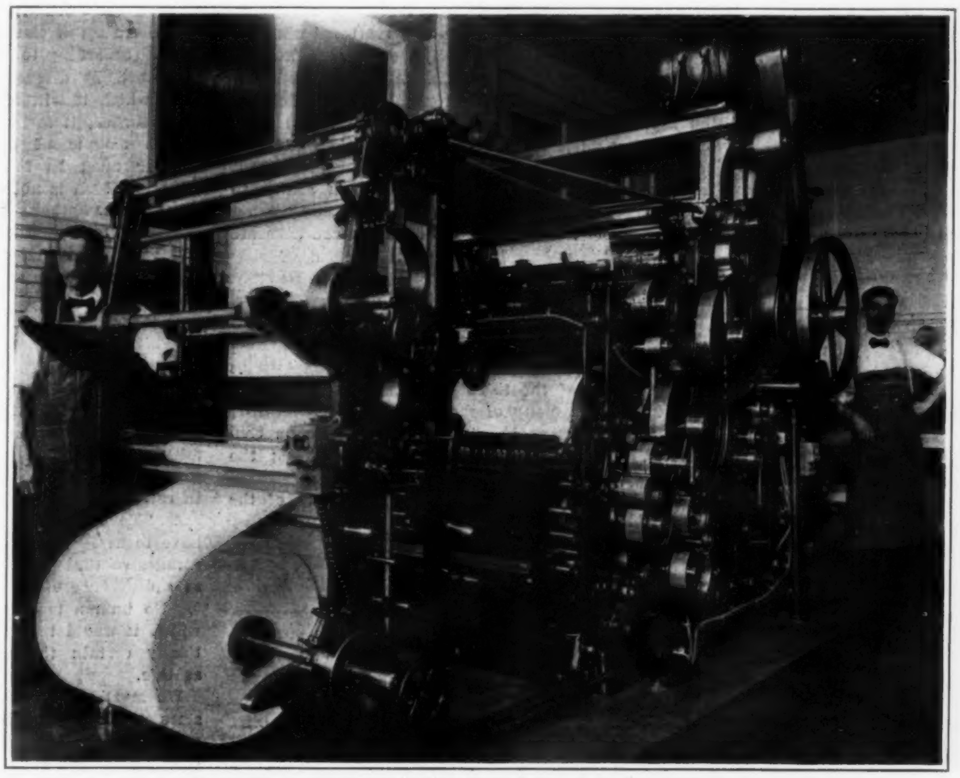
The printing of post office money orders by the government, is one of the new departures recently made by government officials. Until the beginning of the last fiscal year, "Uncle Sam" has been hiring a private company to print the many millions of blank money orders furnished to the many thousands of money order offices all over the United States. One can hardly realize the magnitude of this one job of printing. A private company cannot afford to properly equip itself to do such special work unless it has some assurance of getting the job for a longer period of time than four years. Again, it is not to the best interest of the public that the contract be awarded for a longer period. The private companies who have been printing the money orders have used the sheet presses. The paper was in sheets of a certain size and these had to be fed into the press one at a time. As money orders are printed in three colors, this necessitated feeding them through the press three times, then they had to be cut apart and made up into books. It was due to the enterprising work of Mr. Donnelly, the public printer, and his subordinates that this method was departed from and that the government printing office obtained the contract to print the money orders for the next four years. They are now printed from large rolls of bond paper, wide enough to accommodate two orders lengthwise across it. The speed is double that formerly obtained, and the number of employees is considerably reduced.

The presses now used for this work have been especially designed and built for the government. The complete order, including the purchaser's receipt and the post master's coupon, is printed, cut into sheets of five orders each, and the sheets perforated and collated at one operation. The face and back of the order are printed in black, while the name of the post office to which it is to be sent, and the numbers are in red and the money order seal is in blue. The printing at one operation requires a three color press.

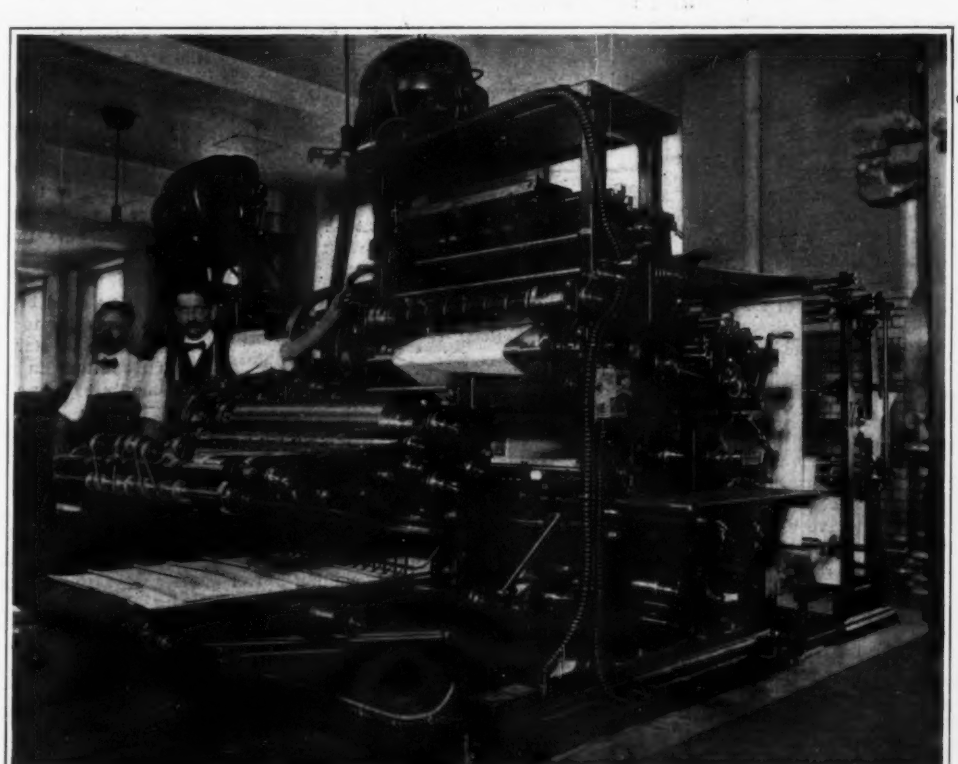
A few months ago there was a considerable change made in the size and form of money orders. Prior to the change the order and postmaster's coupon were printed on one kind of paper, then the purchaser's receipt and a duplicate of the order, or advice, as it was called, were printed on another kind of paper, and these had to be run alternately together. The advice had to bear the name of the same post office, and it, as well as all the other parts, had to be numbered the same as the original order. To do this required a considerable amount of very careful work. This cumbersome form has been completely abolished and a more simple one adopted. The length of the order was increased from 8½ to 11 inches. There are two lines running across the order dividing it into three parts. The first part, or stubb, is the issuing office's record; the second part is the order; and the third part is the purchaser's receipt. This change saves not only the trouble and expense of printing and collating the extra sheet of paper, but saves the expense of an envelope and the mailing of an advice each time an order is issued. It also diminishes the size of the money order books by nearly one-half, thus saving a considerable portion of the expense of sending them to the postmasters.

When the orders were printed by a private company, they had to be shipped to the Post Office Department in Washington at an expense of 3 cents per book and then reshipped to post offices as requested. The little item of three cents per book amounted to about $20,000.00 per year. Now that they are printed in the government printery, they are sent direct from there to the postmasters, by registered mail, as directed by the Post Office Department. The Post Office Department receives requests from the different postmasters for money orders, and after making a record of them turns them over to the Public Printer and he has the orders filled as soon as possible.

The books are made up in various sizes, depending upon the size of the office. The smallest amount put into one book is fifty orders, while the largest is two hundred. When the requests for orders are received at the printing office, they are assorted according to the size of the offices. Ten requests of uniform size are taken and the names of these ten offices are placed in the printing cylinder, and the numbering heads are changed so as to follow consecutively the numbers of the last order issued to each of these ten offices. If these requests are for two books of one hundred orders each, the press is started and run



Front View of the Press for Printing Post Office Money Orders.



Delivery End, Showing the Sheets As Set in Order by the Machine.

THE GOVERNMENT PRESS ON WHICH MONEY ORDERS ARE NOW PRINTED

until four hundred sheets of five orders each have been printed and automatically counted. One-half of these sheets contain one order each for five of the ten offices and the other half for the other five.

The numbering heads have been placed so that the orders for each office carries a separate series of consecutive numbers. These sheets having been collated by the machine, are taken in packages of one hundred each and covers are placed on them and they are then bound on one edge and afterwards cut into books of 100 orders each.

The roll of paper is slitted in the middle as it is printed and then cut into sheets of five orders each. The machine has a capacity of thirty-three hundred books of two hundred orders each in eight hours, which is more than double that of the old press formerly used. The motive power is electricity and the machine is equipped with six electric stations from either of which it can be stopped or started at will. The plates used are capable of making about three millions impressions before they have to be renewed.

One of the interesting features of the government's printing the blank money orders is the saving of thousands of dollars on the cost of them each year. The contract price with the private company for the printing of the old form of orders and advices was 34 cents per book and then 3 cents per book for shipping them to the Post Office Department at Washington.

Then there was the handling of them and the expense of sending them to the postmasters. Now that they are printed in a government printery, at an expense of only 21 cents per book and are wrapped and registered right in the printing office and carried direct from there to the railway station, thus eliminating the expense of shipping them to the Post Office Department and a great deal of handling, there is effected a saving of about $50,000.00 on the blank money orders alone.

The Great Star Map—II*

Star Counting

By H. H. Turner, DSc., D. C. L., F. R. S., Savilian Professor of Astronomy in the University of Oxford

Continued from Supplement No. 1861, page 148.

The map is to be a record of the positions of all stars brighter than a certain standard and will indicate the approximate brightness of each star. Before following the history of the project further, it is desirable to consider what are the problems which may be solved by the accumulation of such information, and cannot be solved without it.

What can we learn, it may well be asked, of the great universe of stars from observations made under the severe restrictions which limit astronomers? We are permanently bound to a small satellite attendant upon one of the stars; other stars are at distances so vast that their movements are only discernible with difficulty; can we learn anything at all about their arrangement in space?

At first sight the inquiry might seem well-nigh hopeless but with a little persistence we find that the chances of learning some essential facts are not to be despised; some, it is true, can be learned only after centuries of labor but there are one or two which have been established without very much trouble. For instance, it does not take long to satisfy ourselves that the stars are not scattered simply at random through space: it may take a long time to find out what their particular arrangement is but we feel confident that there is some arrangement for reasons which may be indicated as follows:

The stars have been divided into classes according to their brightness, such that each class (or "magnitude") is fainter than the one above it in a constant ratio. There is of course no sharp distinction obvious in the sky between one class and the next; the brightnesses vary by imperceptible steps, the abruptness of class division being entirely artificial. But it will make the argument simpler and obscure nothing if for the moment we suppose these class divisions made somewhat abruptly: let us imagine all the stars in each class to be exactly of the average brightness of the class, instead of grading off by small stages into the classes above and below. Now there is overwhelming evidence that these differences in brightness are partly actual differences in the stars themselves and partly the effect of distance. It is certain that the stars are not all at the same distance from us; it is just as certain that, if they were, they would not appear of the same brightness. Taking any particular star of magnitude 2 say and distance 10, we could make it appear of the third magnitude by removing it to distance 16, of the fourth magnitude by removing it to distance 25, of the fifth to distance 40, and so on. Let us suppose spherical surfaces described about the earth with radii proportional to

10 16 25 40 63 100 160 250 etc.

[This series is determined by the convention about star magnitudes and we need not stop to explain it: but it will be noticed that after five terms it is repeated on ten times the scale; there is no difficulty in continuing it indefinitely both ways by means of this principle.] And now let us suppose all the stars in the neighborhood of these successive surfaces to be actually collected upon them, which will save us the inconvenience of intermediate grades. Then if the stars had happened to be all of the same intrinsic brightness, those on the first surface (with radius 10) would appear to us of the second magnitude; on the second surface (16) of the third; on the third surface (25) of the fourth, and so on. The difference in magnitude would be purely apparent and simply an effect of distance. This, as already remarked, is far from being the case; but before dismissing the possibility we will consider an important consequence of it.

The number of stars on the successive surfaces will increase rapidly outward. The surfaces themselves increase in area and the distances between them also increase: so that if the stars are scattered through space impartially, the number due to each surface will increase from both causes. A little calculation shows that the resulting increase is as the cube of the radius, so that if there were 1,000 (or 10^3) stars on the first shell of radius 10, we should find 4,096 (or 16^3) on the next shell of radius 16, which is about four times as many: on the next shell of radius 25 we should find 15,625 (or 25^3), which is again about four times the number. Had we taken more accurate figures for the successive distances, instead of only approximate values, we should have found a constant ratio, slightly less than 4 for the numbers on successive surfaces. That is to say, that on this erroneous hypothesis of stellar brightness being merely an effect of distance, we should expect to find 4 times as many stars of the third magnitude as of the second; 4 times as many of the fourth as of the third; 4 times as many again of the fifth; and so on continually. Now this expectation is not fulfilled; the ratio is nearer 3 than 4, as the following figures (taken from Newcomb's The Stars: a Study of the Universe, p. 54) show:

Magnitude.	Number of Stars.	Ratio to Preceding.
2	52	...
3	157	3.01
4	506	3.22
5	1,740	3.46
6	5,171	2.97

[We begin with the second magnitude because stars brighter than this are so few that the numbers have an accidental character.]

What reason can be assigned for this discrepancy between expectation and observation? The one first to be suspected is that the considerable assumption just made, that the stars are all of the same intrinsic brightness, is not correct and is answerable for the discrepancy. But on examination we very soon find that error in this assumption can only increase the discrepancy and is without effect in diminishing it. Suppose for simplicity there were two kinds of stars, one much brighter intrinsically than the other. It will remind us that the difference is in the stars themselves, not an effect of distance, if we use two special words such as "brilliant" and "glowing" to distinguish them. Then in the first shell there will be say 50 brilliant and 50 glowing stars (the numbers are only illustrative). Of these the brilliant stars will appear of the second magnitude say, the glowing stars of the third. We shall thus recognize 50 stars only of the second apparent magnitude, for the more distant brilliant stars will be fainter than this and the glowing ones fainter still. Coming to the second shell, we should expect to find 4 × 50 or 200 brilliant stars which would now appear as of the third magnitude; and 4 × 50 glowing stars appearing of the fourth. Thus altogether we should recognize as of the third magnitude the 200 brilliant stars of the second shell and the 50 glowing stars of the first, making 250 or 5 times the 50 of the second magnitude. Splitting up the stars into two classes has thus enhanced the expected ratio 4 in this instance and made it 5. If we go to the next magnitude we shall find that the ratio returns to 4 and remains at 4 ever afterward; it is therefore only altered for one step but this alteration is an increase; there is no diminution available for explaining the observed drop toward 3.

We have taken a very simple case; but its characteristics are maintained in the most complex cases we can devise. They may be stated thus: Just as the ratio 4 was disturbed for the first two magnitudes by dividing the stars into two classes, so if it be assumed that there are n classes of diminishing intrinsic brilliance (according to steps of a magnitude each), the ratio will be disturbed for the first n magnitudes, after which it will return to 4. In whatever way it be disturbed, it is increased and not diminished.

This avenue of escape is therefore closed and another must be found. Perhaps the figures used are wrong? It is not likely that the counts are wrong for they have been gone over many times; but is it certain that the drop of a magnitude in brightness is identified correctly? Accurate measures of brightness are not easy to make, as we find in everyday life in connection with candle-power tests. They are harder still for faint lights such as the stars, and the difficulties increase as we pass to fainter and fainter stars. We shall presently have to consider these difficulties in connection with the project of the Great Star Map itself. But for the moment it need only be pointed out that it seems unlikely that the discrepancy under investigation is attributable to such a cause. It is easy to calculate what must be the error in estimation of a whole magnitude if such were the case. To make the ratio 3¼ instead of 4 we should have to be 20 per cent wrong in the measure of magnitude, so that we should be estimating erroneously as a difference of 6 magnitudes what was really only 5. No human measures are perfect but, for reasons which it would take too long to give here, it is practically certain that our estimate is not so wrong as this.

We must go back to an earlier assumption that the stars are scattered impartially through space; this cannot be the case, at any rate in the neighborhood of our sun. We have so far been considering only the brighter stars (roughly speaking those visible to the naked eye) and these must be nearer to us (other things being equal) than the fainter. It is after all not unnatural that in the neighborhood of our sun the stars should not be scattered at random; for we see in the sky many "clusters" of stars and it is not unreasonable to suppose that our sun may belong to such a cluster or cloud of stars. The result would be an excess of stars near us and therefore bright. And to see that this will explain the observed facts we have only to turn our argument round. Hitherto we have argued from the number of bright stars how many faint ones there ought to be and found the estimate deficient. If we start with the observed number of faint stars and calculate how many bright ones there should be we shall find them in excess and the excess is due to the solar cluster. As an illustration, suppose we start with the number of stars of the sixth magnitude in the table given above and divide continually by 4, we get:

Magnitude.	Number of Stars.		Excess Due to Solar Cluster.
	Calculated.	Observed.	
6	(5171)	(5171)	(0)
5	1293	1740	457
4	323	506	183
3	81	157	76
2	20	52	32

and we have accordingly assigned 748 stars to the solar cluster. We have not much guidance as to the accuracy of this crude supposition but it is certainly well within the limits suggested by other clusters. On a photograph taken at the Yerkes Observatory of the great cluster in Hercules, Mr. W. E. Plummer measured over 2,000 stars clearly belonging to the cluster; and just as this particular plate recorded more stars than others taken with inferior instruments, so a further improvement on the great Yerkes telescope would probably show an increase in the

* Reprint from *Science Progress*.

number of members of the cluster. There is every chance that the advance has already been made. Within the last few months we have seen the first results of the new 60-inch reflector of the Solar Observatory established by the Carnegie Institution on Mount Wilson, Cal., U. S. A. They are wonderful examples of what may be done in a really fine climate by a master in the construction and use of instruments. For the moment the latest photograph of the cluster in Hercules is not available. But we are indebted to Prof. Ritchey, who made the telescope and took the photograph, for permission to reproduce his picture of the globular cluster in *Canes Venatici*, which admirably illustrates our text. There is no reason why a single cluster should not contain millions of stars; from this point of view, instead of the limits of our cluster being reached at about the sixth magnitude, there is no reason why they should not extend to the seventh, eighth or even much fainter magnitudes. But there are two considerations which make us hesitate to extend very far in this direction. The first is that by doing so we diminish the resemblance to other observed clusters in an important particular. In the clusters which we see in the sky the stars are thickest in the central portions. The law of condensation toward the center has not been exactly formulated (there is room for an interesting research here); but something has been done, for instance, by Mr. Plummer in his paper* on the Hercules cluster; from the figures he gives we can infer that if an observer could be placed at the center of the cluster to count the number of stars of successive magnitudes (as we have been doing for the stars visible from the earth), then the numbers would increase very slowly

NORTH.

The Globular Cluster, Messier 3, *Canum Venaticorum*, photographed by Prof. Ritchey at the Solar Observatory, Mount Wilson.

indeed. The ratio, instead of being 4 or 3, would probably be less than 2. Now, if we look at the numbers assigned to our "solar cluster" by the crude supposition just made, we shall find that the ratio is greater than 2. We can reduce it by reducing the dimensions of the cluster (supposing the cluster to extend no further than the fifth magnitude, say) but the more we extend the cluster the greater we make this ratio. Hence this is, so far as it goes, a reason for moderation, though it must be admitted that the first argument is not very conclusive.

The second and more serious consideration is that, however far we extend the "solar cluster," we do not remove the chief difficulty. The ratio of the number of stars of any magnitude, to that of one magnitude brighter, obstinately refuses to rise up to 4, however far we count. The counting soon becomes very laborious, as may be seen from the figures already quoted. We have over 5,000 stars of the sixth magnitude, which means approximately 20,000 of the seventh, 80,000 of the eighth, and so on; two more steps take us into the millions. It will cause no surprise that the counting has then to be done by inference from samples in different parts of the sky and is no longer complete; but even the imperfections of the counting fail to suggest any escape from the conclusion that the ratio is sensibly less than 4. Does then the "solar cluster" extend indefinitely? This would be only another way of saying that the whole universe is arranged with reference to our sun and its system.

* *Mon. Not. R.A.S.* lxv. p. 812.

A few centuries ago it was natural to put ourselves at the center of all things and to regard the universe as a mere appendage: but we have outgrown this instinct and we now feel suspicious of any suggestion which assigns special importance to our own position. The evidence of the star counts is very striking: but before accepting it as conclusive we feel bound to inquire whether it may not be susceptible of another interpretation.

One such interpretation at least is open to us and our familiar experiences in a fog are enough to suggest it. We know how a moderate fog limits our visible universe in all directions: in front, behind, to the right, to the left, upwards—downwards the earth anticipates the limit but from a balloon the exception would be removed—in all directions there seems to come an end to our surroundings at about the same distance. If we move about, objects appear suddenly within this charmed circle in front and leave it as suddenly behind us. Were it not for our independent knowledge, we might believe that we were the center of all things: as it is, we attribute the appearance of centrality to the fog. Even if the fog were not in other ways obvious—if, for instance, it were night-time and the fog were too thin to irritate our nostrils—we might infer its existence from the fact that the street lamps seemed only to extend to a certain distance, instead of being visible indefinitely.

A closely similar explanation can be given of the appearance of centrality suggested by the star counts: the universe may be filled with a slight fog. It must, of course, be so extremely tenuous that the name fog is completely unsuitable; for that name suggests to us something which quenches light very rapidly, so that within a few yards (sometimes within a few inches) the brightness of a light would be reduced to one-half. The "fog" in space must require at least thousands of billions of miles to effect the same reduction to one-half. The size of these figures does not mean that they are hopelessly vague; indeed we are almost in a position to say that the number of thousands of billions must be greater than 4 and less than 40, for various independent discussions of this most important matter have been made recently, and they all point to figures within the limits just specified.

From the star counts alone we could not infer the existence of this light-extinguishing medium, which we may continue to call a "fog" for brevity. At any rate the alternative of a limited universe would have equal claims to consideration. But the evidence for the fog has been steadily growing. In the first place we have had before our eyes for centuries the spectacle of finely divided matter being driven off into space—in comets' tails and in the sun's corona. There are various interpretations of both these phenomena but the facts cannot be accounted for completely without some hypothesis of the escape of matter into space. Again, it has been realized that particles must be continually escaping from planetary atmospheres such as our own. There is, in fact, no doubt of the existence of matter in the spaces between the stars: the only question is as to its amount. And, as a second line of evidence, the spectroscope seems to indicate that the amount is appreciable. Prof. Newall of Cambridge was so much impressed with the accumulated evidence of the spectroscope that he devoted to the subject a special presidential address to the Royal Astronomical Society in February, 1909. "Here, then," he summarized, "are a few reasons for looking into possible practical ways of justifying the belief that in space, especially in the neighborhood of suns, there must exist matter forming extended atmospheres." The phrasing is evidently that of a cautious reasoner; those who care to read the whole address will find ample confirmation of the suggestion that it is no idle speculation that is being put before us but a conclusion toward which we are urged from more than one side. Thirdly, there is a direct test for the existence of a fog which has been applied to the depths of space with apparent success. We all know that the sun looks red in a fog, because the red rays of light can penetrate a fog better than the more refrangible blue rays. For a similar reason our electric lights, being bluer than gas, suffer obscuration more readily in a fog. If, then, there be a fog in space, the more distant stars ought to appear redder than the nearer. The test, however, is not so easily applied to faint objects; for one thing we lose the sense of color when the light is very faint. But there is one characteristic of red light that is familiar to all photographers; it takes longer to photograph it, unless we use special plates. We have then merely to ask the question, does the exposure required for the more distant stars increase in an unexpected way? The answer is certainly in the affirmative, though we must be careful that there is not another possible interpretation. From the very beginning of the work on the Great Star Map it has been a serious and fundamental difficulty that, when the exposure was doubled, the gain of faint stars on the plate was not so great as visual observations would lead us to expect. The expectation was founded on laboratory experiments, which show that, within proper limits, a light half as bright as another will give the same photographic effect if the exposure is doubled. "Within proper limits"—here is the need for care; the law breaks down when the light is very faint indeed and we must be careful not to mistake a breakdown from this cause for a cosmical phenomenon. The "proper limits" are still under investigation but they have already been subjected to careful scrutiny; a considerable research by Dr. C. E. K. Mees and Mr. S. E. Sheppard (to quote a single instance) indicates that the limit is reached, for such plates as are used in the Great Star Map, at about fifteen minutes of exposure.[2] Now well within this limit—for exposures of a few minutes only—we find that the difficulty of photographing faint stars is out of proportion to our visual expectations; and it is a fair conclusion that the difficulty arises from the characteristic property of a fog. There is room for difference of opinion as to the intensity of the fog, for the observations are difficult to interpret and even treacherous; but two separate discussions indicate as rough limits the figures which were given above. A discussion by the present writer,[3] assigning the whole of the difficulty to the fog and thus giving probably a maximum density to it, make it extinguish half the light in about 4,000 billion miles. A more conservative estimate by Prof. Kapteyn of Groningen, who allowed for other possible contributing causes, makes the density about one-tenth as great. We must hope that further research will narrow the trail but it will be surprising indeed if we find that we are altogether on a false scent.

(To be continued.)

Variation in the Purchasing Power of Gold

Many people find it difficult to understand how the value of the dollar can vary when one standard weight of gold is fixed by law as constituting a dollar. The answer given in treatises on economics, of course, is that gold is a commodity and, like any other commodity, its value varies according to supply and demand. The most satisfactory explanation, however, is the practical one that the value of the dollar is always measured by what it will buy, and that if prices rise so that a dollar will buy only three-quarters as much at one time as it did at some former time, the value of the dollar has been actually reduced by 25 per cent.

A bulletin just issued by the Department of Commerce and Labor, showing relative average wholesale prices of commodities for the years from 1890 to 1910, gives an interesting tabular exhibit of the great variation in prices and in the purchasing power of a dollar's worth of wages that has taken place during those years. The average is based upon the wholesale price of 257 different commodities.

Relative Wholesale Prices of Raw and Manufactured Commodities and of All Commodities Considered, 1890-1910.

(Average price for 1890-1899 = 100.0.)

Year.	Raw Commodities.	Manufactured Commodities.	All Commodities.
1890	115.0	112.3	112.9
1891	116.3	110.6	111.7
1892	107.9	105.6	106.1
1893	104.4	105.9	105.6
1894	93.2	96.8	96.1
1895	91.7	94.0	93.6
1896	84.0	91.0	90.4
1897	87.6	90.1	89.7
1898	94.0	93.3	93.4
1899	105.9	100.7	101.7
1900	111.9	110.2	110.5
1901	111.4	107.8	108.5
1902	122.4	110.6	112.9
1903	122.7	111.5	113.6
1904	119.7	111.3	113.0
1905	121.2	114.6	115.9
1906	126.5	121.6	122.5
1907	133.4	128.6	129.5
1908	125.5	122.2	122.8
1909	136.8	123.9	126.5
1910	139.7	129.6	131.6

—*Engineering News.*

The Extension of Wireless Telegraphy

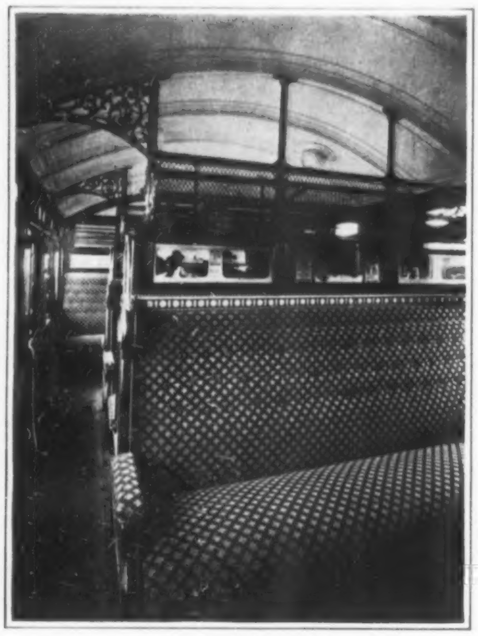
The *Electrical Engineer* gives some interesting figures showing the growth of wireless telegraphy. We read that at the beginning of 1911 there were 1,217 wireless stations in the world, as against 755 at the beginning of 1910. Of these, 998 are on ships and 219 on land.

[2] See *Investigations on the Theory of the Photographic Process* (Longman's) p. 214.

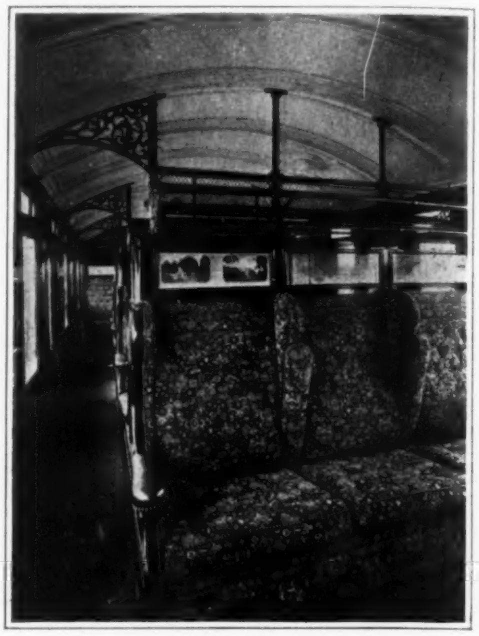
[3] *Mon. Not. R. A.* S. lxix. p. 61.

London's Electric Trains

Railway Engineering in the British Metropolis



Interior of a Third-Class Compartment.



Interior of a First-Class Compartment.

THE extension of electric lines for suburban traffic in London is rapidly progressing. The system as planned comprises a line from Peckham Rye, where a junction is made with the South London line from London Bridge, through East and North Dulwich and Tulse Hill to the Crystal Palace; and another line from Battersea Park, where a second junction is made with the South London line from Victoria, through Clapham Junction, Balham, Streatham Hill, West Norwood (where the first mentioned line is met) and on through Gypsy Hill to Crystal Palace, a distance of about twelve miles. The South London electric line extends from Victoria to London Bridge, and is just under nine miles in length. It is interesting to note that within Victoria Station alone seven miles are being equipped with overhead construction, giving access to five platforms, and in London Bridge Station five platforms have been similarly fitted. The time taken by the steam trains for the trip from Victoria to London Bridge was 36 minutes; electric traction has reduced this to 25 minutes, and permits of very much more frequent service.

The system adopted is that of single-phase alternating current at high tension. Many eminent railroad engineers hold that this is the only satisfactory system for operating any portion of a main line. Geheimrat Wittefeld, chief engineer of public works to the present Ministry, is said to have advised the government that for future railway electrification the single phase system is the only one worth considering. The troubles, both in point of traffic and maintenance, which arise from the use of an insulated third and fourth rail, with the complicated junctions and sidings, place such systems essentially beyond practical utility. The danger both mechanically and electrically to the employees of the railway, as well as the increased cost of maintenance and repairs, and the delays which are apt to arise in consequence of derailment damaging the third rail, were such as to put this system entirely out of court in the case of the Brighton Railway.

On account of the very high pressure of 6,700 volts, at which the current is supplied, only 100 to 140 amperes are required to a train. The circuit breaker in no case need be set at much over 500 or 600 amperes, so that this will be the maximum encountered under any circumstances. Such a current, the maximum which the circuit breakers will allow to pass, would in no case be sufficient to heat the steel work seriously, and thus fire risks are greatly reduced, in the system adopted by the Brighton Railway.

Our illustrations show some of the prominent features of the London system. The current is collected from an overhead wire supported at intervals of about ten feet from two robust steel cables by means of what is known as a collector bow, which is kept pressed against the overhead contact wire by means of a pneumatic device. The contact stripes of these collector bows are composed of aluminium fitted with grooves filled with heavy grease, and the upward pressure against the wire necessary for proper contact amounts to only a few pounds, so that the wear on the copper contact wire is inappreciable, practically the whole wear taking place on the aluminium strip, which can be easily and cheaply removed. The current from the bow passes to the high tension chamber in which are located the various measuring instruments and safety devices, and is then conducted by lead covered cables inclosed in metal casing to the two transformers situated under each motor car. The low pressure current is then taken to the motor and to the controlling apparatus situated at the side of the coach, underneath the frame.

Each train is made up of three coaches, the first and last being a third class carriage fitted at one end with a guard's van and motorman's compartment. The center coach is not equipped electrically and is devoted to first-class passengers. Each of the end coaches carries four 120 H.P. single phase motors of Eichberg's design. The third class coach contains eight passenger compartments providing seating accommodations for sixty-six passengers, but seventy-two people can be seated without discomfort. The first-class coach has nine compartments normally designed to seat fifty-six passengers, though seventy-four can be seated without any difficulty. The seating capacity per train is therefore 238 passengers. The train is handsomely upholstered, as will be seen by reference to the accompanying illustrations, which show respectively a first and third class compartment. The coaches are mounted each on two pressed steel bogies with 42-inch wheels and 8-ft. wheel base. The length overall of a coach is 60 feet, with 41 feet between bogie centers, the width of the centers being 9 feet. In addition to ordinary hand brakes, Westinghouse air brakes of the most well known type are provided throughout the train.

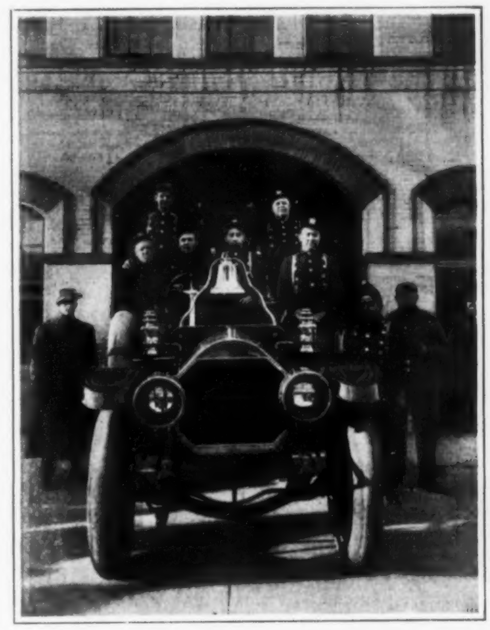
Full Speed Ahead.

ELECTRIC TRAIN SERVICE IN THE BRITISH CAPITAL.

The Motor Fire Engine

The Automobile to the Rescue

Rear View of the Automobile Fire Engine.



The Automobile Fire Engine Ready to Start Out.

In a remarkably short time the automobile fire engine has reached a wonderful state of perfection. The accompanying illustrations show an American automobile fire engine, chemical engine and hose wagon in service and ready for action. One of these auto fire engines tested at St. Louis was able to throw three streams above the Woman's Magazine Building at University City and a single stream from a 1½ inch nozzle to a height of 50 feet above the highest point of that structure.

The triple automobile combination chemical engine, hose wagon and fire engine of the Robinson "Jumbo" type is equipped with an engine of 110 horse-power capacity, which drives the pump at full capacity at a speed of 900 revolutions per minute, the same motor giving abundant powerful high speed travel for hill climbing and pulling the cars through mud or snow.

A vertical motor having six cylinders cast in pairs with a stroke of 6½ inches, and a bore of 5⅝ inches is utilized on this triple auto fire engine. This engine was designed to operate at any speed up to 1,400 revolutions per minute, both intake and exhaust valves being mechanically operated and located in the heads of the cylinders. The cooling of the engine is effected by a gear pump forcing the water through a large square tube radiator, a byepass from the main pump direct to the motor cylinders being provided with regulating valves enabling the operator to keep the motor cylinders at any desired temperature when pumping.

The car is geared for a normal speed of 30 miles per hour, but can be put on double this speed if desired. The hose body has a capacity for 1,000 feet of 2½ inch rubber lined cotton hose, and the chemical equipment consists of a 35 gallon chemical engine tank of 6½ lb. hammered copper heavily tinned on the inside and provided with a fan agitator, the entire length of the tank being revolved by a brass scroll wheel to effect thorough dissolution of the soda and to prevent its settling at the bottom of the tank. An independant acid pump is located at the end of the tank.

The fire pump is of the triplex piston type with cylinders 5¾ inches in diameter and of 8 inch stroke. This pump is back geared and driven by a spur gear on the main driving shaft, the pump control being such that when operating, the spur gear is engaged by a positive jaw clutch. The air dome is of 100 lbs. hammered copper tested to 350 pounds per square inch.

In actual service the fire pump on this novel triple automobile fire fighting equipment delivers no less than 700 to 800 gallons of water per minute and will supply as many as three fire streams from 1¼-inch ring nozzles. It will deliver 750 gallons per minute through two lines of 2½-inch hose 100 feet in length, each provided with a 1½-inch smooth bore nozzle drawing from dead suction against a net pump pressure of 110 pounds. It is claimed that the engine will run many hours continuously without over-heating or showing loss of power.

Side View, Showing the Saving in Length as Compared with a Horse-Drawn Engine.

In Operation the Fire Pump Delivers 700 to 800 Gallons of Water Per Minute and Will Supply Three Fire Streams.

THE AUTOMOBILE FIRE ENGINE.

Extensive Seaport Improvements at Havre

About $15,000,000 are to be used in extensive construction work in order to enlarge the port of Havre. The French government decided to carry out the project some time ago, and within a recent date the contract for the whole enterprise was awarded to a syndicate headed by the Schneider company which is operating the largest metallurgical works in the country, and is also engaged in various kinds of construction work. The operations to be carried out at Havre include the building of an inclosing jetty of some 13,000 feet in length which is designed to protect the new construction against the action of the sea. There is to be also built a large basin which will have 15,000 feet total length of embankments. The north quay alone will figure for 3,300 feet of length. At the foot of the quay the basin will be excavated to 40 feet below the lowest tidal level and for the rest of the basin to 20 feet. Along a central mole will be placed a series of pontoons in order to give the proper landing accommodations for the large coaling vessels which supply the ocean liners. Another large piece of work is a repair dock able to take vessels of 1,000 feet length. It can afterwards be enlarged for use with 1,200-foot vessels and can have 130 feet width, with 42 feet depth of water. There are also several other pieces of construction work which are intended to enlarge the port or to give the needed protection. This enlargement may have an influence on the future construction of ocean liners in France. In a paper presented by M. Godard, a prominent shipbuilder, before the Civil Engineering Society, he mentions the new ocean steamer "France," having 30,000 tons, and states that the reason why it was not built still larger was because the port of Havre to which it belongs would not allow of this. When the new basins in course of construction are in use, it is certain that much larger steamers can be built. It is recognized that there is an increasing need for larger steamers either for obtaining an increased speed or again to lower the expense of running, as is now required by the active competition which prevails in all parts of the world. When the present work is carried out it will place the port of Havre in the front rank among modern seaports and will enable it to receive vessels of any tonnage and of draughts even exceeding 45 feet.

Starting a Gas Engine With Steam

A correspondent in "Power" writes: "Some time ago I had charge of a city water and light plant in which two auxiliary generators were driven by a gas engine. One night before starting the gas engine to keep the steam-engine units over the peak of the load, I found the air compressor out of commission and could get no air; neither could I repair the compressor in time to start up. The gas engine was a three-cylinder vertical, with 13x14-inch cylinders, and was usually started by introducing air into one cylinder. I decided to tap the steam line and start with steam in the same way that I would with air and change the igniter in the starting cylinder on the run, as I felt sure it would be "drowned out" by the steam. Much to my surprise, however, it fired perfectly. Of course, I used no more steam than was necessary and blew out the steam line until it was quite dry before turning steam into the cylinder. This method of starting proved so satisfactory that it is still in use, after three years' trial." Here we have a practical suggestion that seems well worth noting, which may prove useful to our readers, who have to handle gas engines.

Practical Aspects of Printing Telegraphy—VII*

An Inventor on the Difficulties to be Encountered and the Way to Overcome Them

By Donald Murray, M.A.

Continued from Supplement No. 1861 page 150

THE MURRAY MULTIPLEX PAGE-PRINTING TELEGRAPH.

Although the relative advantages and disadvantages of automatic and multiplex printing telegraphs appear to be obvious and are now tolerably familiar to telegraph engineers, this knowledge has only been gradually accumulated during the past few years as the result of prolonged trials of various automatic and multiplex printing telegraphs. The British and German administrations especially have carried out a very large amount of experimental work with various telegraph systems, including the Murray automatic. The idea of combining the advantages of the automatic and multiplex systems led to the development of the Murray multiplex printing telegraph. It is only about a year since this system passed out of the laboratory stage and arrived at practical success. The Murray automatic system may be said to be based on the Wheatstone automatic transmitter. The Murray automatic transmitter is greatly modified, but the essential principles of the Wheatstone transmitter are embodied in it. In a multiplex system the instrument corresponding to the Wheatstone automatic transmitter is the distributor, and the Murray multiplex system may similarly be said to be founded on the Baudot, because it has taken the Baudot distributor as its basis. For driving the distributors, however, instead of the Baudot arrangement, the Delaney multiplex plan of using the Lacour phonic wheel motor is adopted. Apart from the distributors, the only resemblance between the Baudot and the Murray multiplex is in general principles and in the use of the Baudot alphabet. The Murray multiplex transmitting and printing machines closely resemble the corresponding Murray automatic instruments. Many are indeed identical. The normal speed of the Baudot is 30 words a minute for each transmission. In the Murray multiplex the speed is raised to 40 words a minute, in order to increase the efficiency of the labor at both ends of the line. It is possible that under certain conditions it may prove advantageous to increase the speed still further to 45 or 50 or even 60 words a minute. There are considerable possibilities of both capital and labor saving by such increased speed, and the Murray multiplex has the advantage of easy adjustment of speed over a considerable range from 20 up to 45, and possibly 60 or more words a minute for each transmission or channel.

Like the Baudot and similar systems, the Murray multiplex printing telegraph divides up the line time so as to give several transmissions or channels on one telegraph wire, each at a comparatively low speed suitable for the work of one operator sending and one receiving. Two distributors, identical in design, are employed, one at each end of the telegraph line (station A and station B). The distributor at station A sends out a governing impulse once for each revolution of the contact arm (four revolutions per second for 40 words a minute). This impulse controls the speed and phase of the distributor at station B so as to keep it running in synchronism with the distributor at station A. The distributor used in the Murray multiplex is shown in Fig. 7. This instrument is a

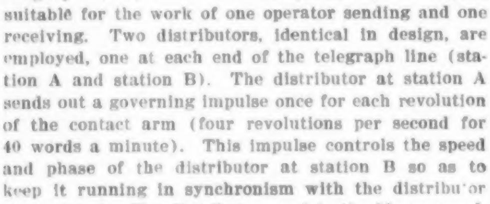


Fig. 7.—Front View of Murray Multiplex Distributor.

"double," giving two simultaneous transmissions working simplex and four when working duplex. The new system may also be worked "triple" or "quadruple," the duplex balance in these cases giving 6 or 8 transmissions simultaneously on one line. Special arrangements have been designed to give up to 6 transmissions in each direction, but it seems unlikely that anything more than quadruple duplex (8 transmissions) will ever be required in practice.

The distributor brush arms are carried directly on the spindle of a phonic wheel motor, which is identical in all respects with the phonic wheel motor employed in the Murray automatic system, and it is driven in the same way by a vibrating reed. There are no gearwheels or governing mechanisms. The commutator and contact arms and brushes are the same as

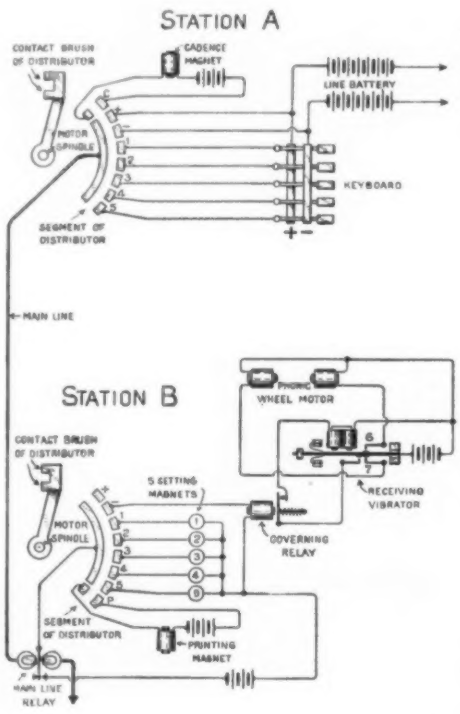


Fig. 8.—Diagram of Murray Multiplex System.

in the Baudot, and the adjustments are the same. The distributor fits on to a wooden base provided with spring contact terminals, so that the machine may be instantly lifted off or replaced. This distributor will work perfectly in conjunction with Baudot distributors and other Baudot apparatus. It has the advantage over the Baudot of being simpler, cheaper, and easier to construct. On the other hand, where Baudot distributors are already in use, the Murray multiplex transmitting and printing mechanisms will work excellently with the Baudot distributors. It will be noticed that the Baudot commutator and revolving brush arms take the place of the automatic transmitter driven by the same phonic wheel motor in the Murray automatic system. The Murray multiplex, in fact, combines many features of the Murray automatic and of the Baudot, and a considerable portion of the apparatus, with slight modifications, is interchangeable in all three systems.

The theoretical arrangement of the electrical connections in the Murray multiplex is shown in Fig. 8. One of the transmitting channels or segments of the distributor and revolving contact brush are shown at each station. For the sake of clearness the other segments for the other transmissions on the same telegraph line are omitted, and for the sake of simplicity the Baudot 5-key transmitter is shown at station A. Also at station A the vibrator and phonic wheel that keep the contact brush of the distributor revolving are omitted. The five transmitting keys at station A normally rest against the top contact bar, which is connected to the negative end of a split battery. The depression of any key breaks contact with the negative bar and puts the key into contact with the positive battery bar. The keys are connected to the contact blocks 1, 2, 3, 4, 5 of the distributor. Various permutations of five positive and negative impulses are transmitted into the line as the distributor arm revolves. In the Baudot system the sending operator has to learn to manipulate these five keys in the 31 different permutations required, and he has to depress the keys at regular intervals, determined by the cadence magnet which is operated by the distributor three times a second, the normal speed of the Baudot being 30 words a minute for each transmission. This method of transmission has the advantage of simplicity of mechanism, but it requires special skill and training on the part of the operator, the work is very monotonous, and the speed is limited to about 30 words a minute.

A typewriter keyboard mechanism to operate these five contacts can be easily designed. Such a machine made by the writer for use with the Murray multiplex is shown in Fig. 9. The five contacts corresponding to the five keys in the diagram, Fig. 8, may be seen on the left of the instrument. There is also a cadence magnet on the left which locks and unlocks the keys to enable them to be depressed at the right moment. On the right there is a letter-counting magnet, which rings a bell at the end of each line of about 60 letters. This is a first-class instrument of its kind, simple, strong, and cheap to make; but as the result of careful practical trials by the British Post Office, automatic tape transmission was found to be so much superior to direct transmission that direct transmission was abandoned altogether, so far as the Murray multiplex is concerned.

Actual trial between London and Birmingham for several weeks showed the advantages of automatic tape transmission over direct transmission to be as follows:

1. The output of messages per operator per hour is practically doubled compared with direct transmission.
2. There is less nerve strain on the sending operators, because there is no cadence to be observed.
3. Much more skill is required to work on the direct cadence keyboard than on the keyboard perforator. This has been proved conclusively by practical trials.
4. Provision is made for quick and invisible correction of errors before transmissions in the case of the indirect method of tape transmission in the Murray multiplex. Practical experience has shown that this is a valuable feature with page-printing. With direct transmission all errors appear in the printed message. Also errors are more numerous with direct than with tape transmission, operators being able to do more accurate work on the free keyboard of a keyboard perforator, compared with a direct transmitting cadence keyboard.

The trials were made at 40 words a minute instead of the normal Baudot speed of 30 words a minute, the increased speed being one of the advantages gained by the use of a typewriter keyboard.

The instruments used in the Murray multiplex for tape transmission are shown in Fig. 10.

On the right at *A* is a keyboard perforator identical with that used in the Murray automatic system. The tape passes from the perforator into an automatic transmitter *B*. This automatic transmitter is the same as the tape-feeding mechanism of the Murray automatic printer, except that the tape-feeding mechanism is driven in this case by a magnet instead of by a cam. The magnet is operated at regular intervals —four times a second—by the cadence contact on the distributor. This is equivalent to a speed of 40 words a minute.

After running through the automatic transmitter the tape passes on to an automatic tape-winder *C*. This instrument is of a very simple character and is entirely automatic. Both sides of the tape may be used, so that the cost of the tape is small. The tape also forms a complete "home record" of what the

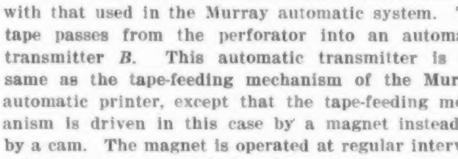


Fig. 9.—Direct Keyboard Transmitter for Murray Multiplex System.

operator has sent. It is neatly woundup without labor cost, and there is no mess of tape on the floor. There is one of these automatic transmitters for each sending operator, so that an extra transmitter attendant is not necessary.

As the automatic transmitter runs steadily at 40

* Paper read before the Institute of Mechanical Engineers.

words per minute, it may at times overtake the operator. A starting and stopping lever is therefore provided on the automatic transmitter shown at *S*. This is arranged with a locking mechanism so that the operator can only start or stop the transmitter at the right moment. There is therefore no danger of interrupting a letter signal in the act of transmission, thereby causing a wrong letter to be transmitted. In

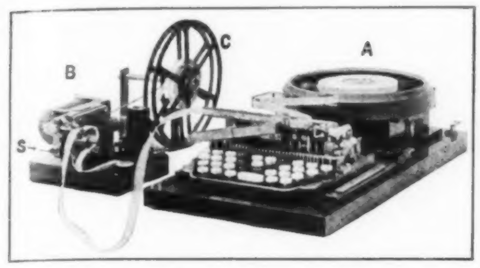


Fig. 10.—Tape Transmission Equipment of Murray Multiplex System.

this way the operator has complete control over the tape. He can start or stop transmission at will. He can pull back the tape and repeat a message. He can correct errors instantly and invisibly. He has a perfectly free and extremely rapid typewriter keyboard, which he can operate as fast or as slowly as he pleases. Only typewriter skill is required, and there is no cadence to be observed.

It is to be noted that it is possible to make a much simpler tape transmitter than that shown in Fig. 10 if the perforations in the tape are arranged crossways, but in that case the tape would not be interchangeable on the Murray multiplex and the Murray automatic systems. At present the tape is identical for the two systems, and it appears desirable to preserve this identity, even at the cost of a little greater complexity in the mechanism of the transmitter.

It will be noticed that tape transmission involves considerable increase in capital cost compared with direct transmission, and it also involves cost for paper tape, but the saving in line and labor is so great that it far outweighs the increased expenditure. Also, if a perforator and tape transmission are not used, then a printer has to be available to enable the operator to see what he is sending out—that is, to supply a "home record." With tape transmission the tape serves as the "home record." The cost of the perforator and transmitter are therefore about balanced by the cost of a printer.

One disadvantage of tape transmission is that a rapid operator may go on perforating until he is several messages ahead of the transmitter. An inquiry may then come through from the other station, and the operator cannot transmit his answer until the messages already perforated have been transmitted. This may take two or three minutes, and it would delay delivery of a message at the other station. An arrangement has accordingly been designed, by throwing over a switch, to convert the keyboard perforator temporarily into a direct transmitter. The tape transmitter is switched out, and the punching magnet of the perforator becomes a cadence magnet. Five contacts are provided on the perforator to be operated directly by the keys. Although direct transmission is not so good as tape transmission, there is no objection to its use for sending a few words of reply to an inquiry. As soon as the reply is transmitted the switch is thrown over again and tape transmission is resumed at the point where it was stopped. The printing mechanism at the other station for recording this temporary direct transmission will be described presently. This arrangement enables direct and instant reply to be made to an inquiry, but it is doubtful whether it would be required in all cases.

Fig. 11.—Murray Multiplex Printer—Side View.

Returning to Fig. 8, it will be noticed that there are two contacts on the distributor at station A which are connected direct to the plus and minus poles of the battery. A positive and a negative impulse are therefore sent into the line with each revolution of the contact brushes. This is the governing impulse which controls the speed of the distributor at station B. The method of governing is similar to that employed in the Murray automatic system. The receiving vibrator at station B is identical with the receiving vibrator in the automatic system. It is provided with buffer springs so that the speed of the vibrating reed varies with the variation of the electric current driving the reed. The contacts 6 and 7 on the receiving vibrator, instead of operating a receiving perforator as in the automatic system, energize the two magnets of the phonic wheel-motor driving the contact brushes of the distributor at station B. Varying the speed of the reed will therefore vary the speed of rotation of the distributor contact brushes. Let us assume that the contact brushes at the two stations are revolving at the same speed and that they are in phase with each other. Then, when the brush at station A is on the plus contact of the distributor, the brush at station B will be on the positive contact of the distributor at station B. A positive impulse will flow into the line at station A and will operate the main line relay at station B, closing the relay contact; but there will be no local action in consequence of this at station B, because the plus contact on the distributor is an idle contact with no connection. It will be seen that there is a local battery and a circuit passing through a local relay described as the governing relay. When the two brushes at the two stations reach the two negative contacts on the two distributors the main line relay contact will be opened, and there will be no local action at station B. If now the vibrator at station B is adjusted to run 1 or 2 per cent faster than the vibrator at station A, then the rotating brush of the distributor at station B will run 1 or 2 per cent faster than the brush at station A. Hence when the brush at station A is on the plus contact, so that the main line relay contact at station B is closed, the brush of the distributor

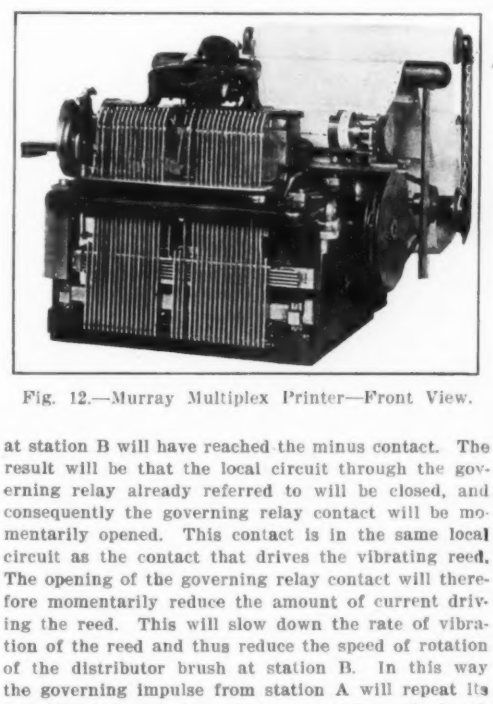


Fig. 12.—Murray Multiplex Printer—Front View.

at station B will have reached the minus contact. The result will be that the local circuit through the governing relay already referred to will be closed, and consequently the governing relay contact will be momentarily opened. This contact is in the same local circuit as the contact that drives the vibrating reed. The opening of the governing relay contact will therefore momentarily reduce the amount of current driving the reed. This will slow down the rate of vibration of the reed and thus reduce the speed of rotation of the distributor brush at station B. In this way the governing impulse from station A will repeat its retarding influence four times a second on the brush at station B. In this way the two brushes at stations A and B are kept not only at the same speed but also in phase, so that when the brush at station A touches successively contacts 1, 2, 3, 4, 5, the brush at station B will also be touching successively contacts 1, 2, 3, 4, 5 on the distributor at station B. Any permutation of signals sent out from the keyboard at station A will therefore be exactly reproduced in the five setting magnets of the printer at station B.

The printer, of which there is one for each channel or transmission of the multiplex, is shown in Figs. 11, 12, 13, 14 and 15; 11 is a side elevation, 12 is a front elevation; 13 is a sectional side elevation, 14 is a plan of the selecting mechanism with the typewriter removed, and 15 is a plan of one of the 5 setting magnets and the comb that it controls. The printer is driven by a small 1/16 horse-power motor, as shown in Fig. 11. As the printer will print correctly as long as it is driven faster than the distributor, there is no need for synchronism between the printer and distributor, the former being arranged to run anywhere about 20 or 30 per cent faster than the latter. The Blickensderfer typewriter is employed, and the message forms are fed in automatically from a roll made up in a rather unusual way. The message forms are perforated along each side like a cinematograph film, so as to gear on to sprocket pins on each ends of the typewriter platen. The message forms, in addition to being perforated along the edges are lightly pasted together so as to overlap and at the same time form a continuous band, which is wound into a roll. The perforations ensure positive column and page-feed, and the overlap of the message forms renders it very easy to pull the messages apart after they are printed. The printer attendant has merely to pull off the mes-

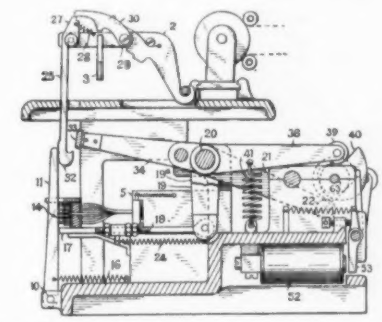


Fig. 13.—Murray Multiplex Printer—Sectional Elevation.

sages one by one as they are finished. This involves an absolute minimum of thought and labor, and he can devote all his attention to checking the messages. The result is that the receiving operator, when everything is running well, can check up to 150 messages an hour.

In the diagram Fig. 8, at station B there are five small setting magnets, 1, 2, 3, 4, 5. These are in the printer, and they record the signals transmitted from stations A. A plan view of one of these five setting magnets of the printer is shown in Fig. 15: 5 is the magnet coil, 72 is the yoke, and 49 is the armature, pivoted at 48 and retracted by the spring 76 against the backstop 74. At the free end of the armature there is pivoted a pawl 75, which passes through a slot 71 in the frame of the machine. Resting against this frame are five differentially slotted "combs," or metal

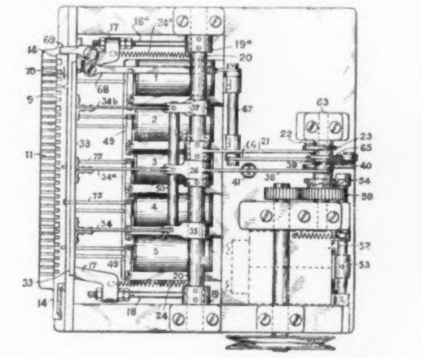


Fig. 14.—Murray Multiplex Printer—Plan View With Typewriter Removed.

strips, lying side by side. One is shown at 14. Each of the five setting magnets controls one of the five combs, the pawl 75 of each magnet engaging in a nick on the inner edge of its corresponding comb. Five springs 73 tend to move each comb 1/16 inch (1.6 mm.) to the left. When a signal energizes one or more of the five setting magnets, the armatures are attracted and the pawls 75 are pulled back out of the way of the combs, which then move suddenly to the left in the direction of the arrow 83, under the action of their springs 73. In this way any given signal is stored up in the printer. Referring to Figs. 13 and 14, the five combs are shown in section at 14 in Fig. 13, and the top comb is seen in plan at 14 in Fig. 14.

Pivoted at 10 and crossing the combs at right angles

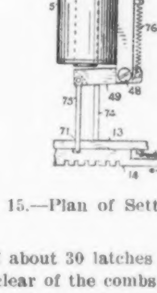


Fig. 15.—Plan of Setting Magnet.

are a series of about 30 latches or crossbars 11. These are held just clear of the combs by the supporting bar 17. Underneath the printer is a printing magnet 52. Referring to the diagram Fig. 8, it will be seen that

this printing magnet is energized by the brush arm of the distributor closing a local battery circuit through the printing magnet immediately after the setting magnets have set the combs in some particular permutation representing a particular letter. In practice the printing contact is placed on an inner ring of the distributor, but for the sake of simplicity it is shown in the theoretical diagram in the same ring as the letter-setting contacts. The printing magnet, being energized, attracts its armature 53, which moves out the pawl 54, Fig. 14 thereby tripping a single-revolution clutch. This clutch, on being tripped, connects a constantly running pinion 58 (driven by the 1/16 horsepower motor) with a cam spindle 63, carrying a battery of three cams. The clutch on being tripped causes the cam spindle to make one complete revolution, the clutch being then thrown out ready for the next printing impulse.

Referring to Figs. 13 and 14, it will be seen that the supporting bar 17 is carried at both ends by two connecting rods 18 and 18*a*, connected to two vertical levers 19 and 19*a*. These levers are pinned to the shaft 20. Pinned to the same shaft is a lever 21 with a cam roller 22. This engages with cam 23, Fig. 14. At the right moment, just after the combs have been set by the setting magnets 1, 2, 3, 4, 5, the cam 23 (set in motion by the printing magnet) allows the lever 21 to rise slightly, thereby pulling in the supporting bar 17 by means of the springs 24 and 24*a*. This allows the crossbars 11 to rest against the combs, the crossbars being pulled inwards by springs 16, Fig. 13. For any given signal only one group of slots will be in alignment across the five combs, and into this group of aligned slots in the combs one particular crossbar drops forward and throws the hook 32 of the hook lever 25 under the universal striking bar 33. These hook levers swing on a pivot on each typewriter key lever 2. The top of the hook lever 27 is prolonged into a catch. On each key lever 2 there is pivoted at 29 a pawl 30. The free end of this pawl rests normally on top of the catch 27 of the hook levers 25. When any given lever 25 is swung inwards by a crossbar, the pawl 30 drops down at the back of the catch on top of the hook lever 25, and holds the hook in the **inward position under the striker bar. The letter signal from the distant station has thus been transferred from the magnets to the combs, from the combs to the crossbars, and from the crossbars to one of the hook levers 25 hanging on a particular key of the typewriter.**

The striker bar 33 is carried on the end of three levers 34, 34*a*, 34*b*. These levers are braced into one frame by being pinned to the shaft 50, and they are free to oscillate on the shaft 20 by their hubs 35, 36, 37. From the central hub 36 there extends a lever 38 with the cam roller 39, which is operated by the snail cam 40 on the cam spindle 63. At the right moment this cam raises the lever 38 and depressed the striker bar 33, the striker bar frame oscillating on shaft 20, Fig. 13. The striker bar in its descent engages with the selected hook 32, thereby depressing key lever 2 and printing the corresponding letter on the typewriter. As the key lever 2 descends, the pawl 30 strikes the slotted bar 3 and is thrown out of engagement with the hook lever 25, which is then free to be restored to its normal outward positions by the spring 28 as soon as it is free from the striker bar 33, which is restored to its upper position at the end of each stroke by the spring 41.

The moment a crossbar has thrown a particular hook lever 25 forward into locked position, the supporting bar cam 23, Fig. 14, thrusts the supporting bar 17 forward so as to push out the crossbars, thereby freeing the combs. The moment this happens the combs are restored to their zero position by a third cam 65 on the cam spindle. This cam by means of a chain of levers and shafts, 66, 67, and 68, causes lever 69 at the end of the combs to thrust the combs back in the direction of the arrow 70 to zero position, where they are instantly caught and retained by the magnet armature pawls 75. It will be seen on studying this chain of mechanisms, that the combs can be and are restored to zero position before the depression of hook 32—that is to say, before the printing commences. The result of this is that the setting of the next letter signal by the setting magnets can proceed simultaneously with the printing of the last selected letter. These actions being simultaneous, a more moderate **rate of operation is possible for the same speed than would be possible if the actions were successive. This considerably reduces the noise and wear of the mechanism.**

The printing does not require description, as any ordinary typewriter action, such as that of the Blickensderfer, answers the purpose.

The line and column feeds of the message form are effected in the same way as in the Murray automatic printer. There is a clutch, which is tripped at the right moment so as to connect with the driving power. This winds up a cord, which pulls the typewriter carriage back to the beginning of the line (line feed) and at the same time turns it up to a new line (column feed). The typewriter carriage itself throws out the clutch when it reaches the beginning of the new line. This action is extremely simple and rapid, and gives no trouble. The typewriter carriage returns to the beginning of a new line in the time of one letter—that is to say in one quarter of a second. The time consumed in this way is therefore trifling.

The page-feed of the message forms is affected by rotating the typewriter platen through a fixed distance up to the starting-point of a new message. This is effected by a chain of gears and a single revolution clutch. A particular signal for paging up operates one of the crossbars, and this by suitable intermediate mechanisms trips the clutch so as to page up at the right moment. This paging up to a new message form is also very rapid, taking place in the time of two letters, or half a second. This is not counting the paging up signal. Including the time of this signal, the time of paging up is three-quarters of a second. Page-printing in this machine, therefore, involves only trifling loss of time—on the average not more than 1½ seconds per message, and it saves all the labor and messing and waste of time involved in gumming a tape-printed message on to message forms, the process employed in the case of the Hughes, the Baudot, and other tape-printing telegraphs. Not only does page-printing in the Murray multiplex save time and labor, but the page-printed messages present a good appearance.

(To be continued.)

Freight Handled Mechanically

Electrical Motor Driven Portable Conveyer which Handles Packages, Cases and Lighter Cargo

The facilities for loading and unloading freight at docks are constantly increasing.

The two accompanying photographic views show a Portable Conveyer, built by a firm in Columbus, Ohio, which was recently installed for the Vacuum Oil Co. for delivering outgoing and receiving incoming light freight at their Sydney Dock, Australia.

This machine constitutes a wholly unique freight handling plant, electrically driven, with 1½ horsepower motor, capable of handling 1,000 cases or light packages per hour.

The second view shows the boom lowered and gives a clear idea of the method of unloading. The boxes travel along on the belt and are delivered automatically to the waiting drays. This method has minimized the human labor and reduced the cost of handling at least 50 per cent.

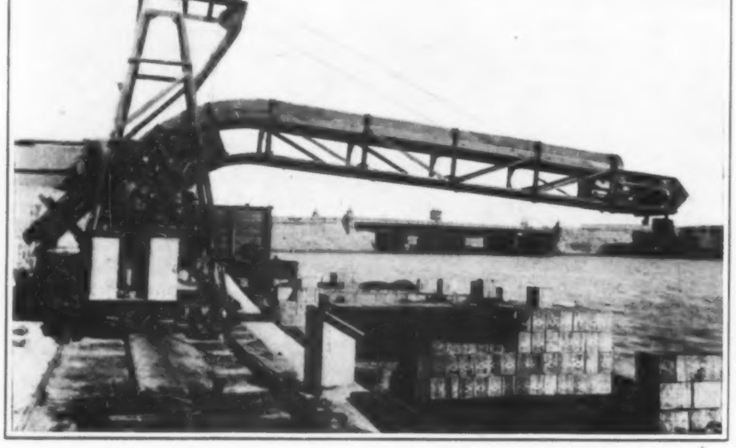


Fig. 1.—The unloading boom raised above the barge.

Fig. 2.—The boom lowered for operation.

The first view shows the boom raised above the barge; the length of the boom is approximately 24 ft. and it is so arranged that it can be raised or lowered as may be necessary on account of the tide. The portable truck carrying the boom, travels on a track extending the entire length of the dock, allowing the machine to be placed at the most convenient point for unloading, or loading as the case may be. This boom is equipped with a continuous, moving conveyer belt. It is upon this belt that the outgoing freight is delivered; the cargo placed on the belt by human labor, descends to the barge from where it is again handled and piled.

The Sun's Distance Determined from Eros

Last year Mr. A. R. Hinks published the result of a very exhaustive discussion of the Sun's distance from the ratio of the earth's mass to that of the sun, from which the distance of the latter readily follows. These perturbations can be expressed as a series of regular waves, or sine-curves, of various periods. The largest wave has a period of 40.6 years, the amplitude of the cosine part of it being —703 seconds, and the argument seven times Eros's mean longitude—four times that of earth. There is another large term with amplitude 259 seconds and multipliers of the longitudes 37 and 21; period 82.6 years. A more accurate knowledge of the period of Eros is required before this last term and the observations of Eros at the time of its near approach in 1900-1901. His final value for the Sun's parallax is 8.806 seconds. Taking the earth's equatorial diameter as 7,925.45 miles, the sun's distance is 92,831,000 miles, with a probable error of some 30,000 miles. This result is very close to that previously deduced by Harkness from a Least-Square adjustment of all available material, and also to Gill's result from the minor planets Iris, Victoria and Sappho. It is expected that Eros will in the course of years afford a much more accurate determination than any yet made, by the very large perturbations which the earth causes in its motion. Careful observation of these will give others of longer period can be accurately calculated. Forty-six revolutions are so nearly equal to eighty-one years that it is still uncertain in which direction they differ. The shift in the planet's place due to these terms is increased by the eccentricity of the orbit, and by the fact that the planet is at times so near the earth that the heliocentric shift is increased sixfold. A total range of some 3 degrees may thus arise, and as the range due to parallax is only 2 minutes at most, it will be seen how much the method of perturbations will eventually surpass the other. It will probably not attain its full accuracy till two or three times the forty-year period have elapsed.—*Knowledge.*

Superheater Using Waste Heat

A Contribution to Factory Economy

The accompanying illustration Fig. 1 shows an enormous 8,000 horsepower superheater, whose duty it is to superheat steam from 8,000 horsepower of boilers by means of waste heat from four billet heating furnaces at one of the plants of the United States Steel Corporation.

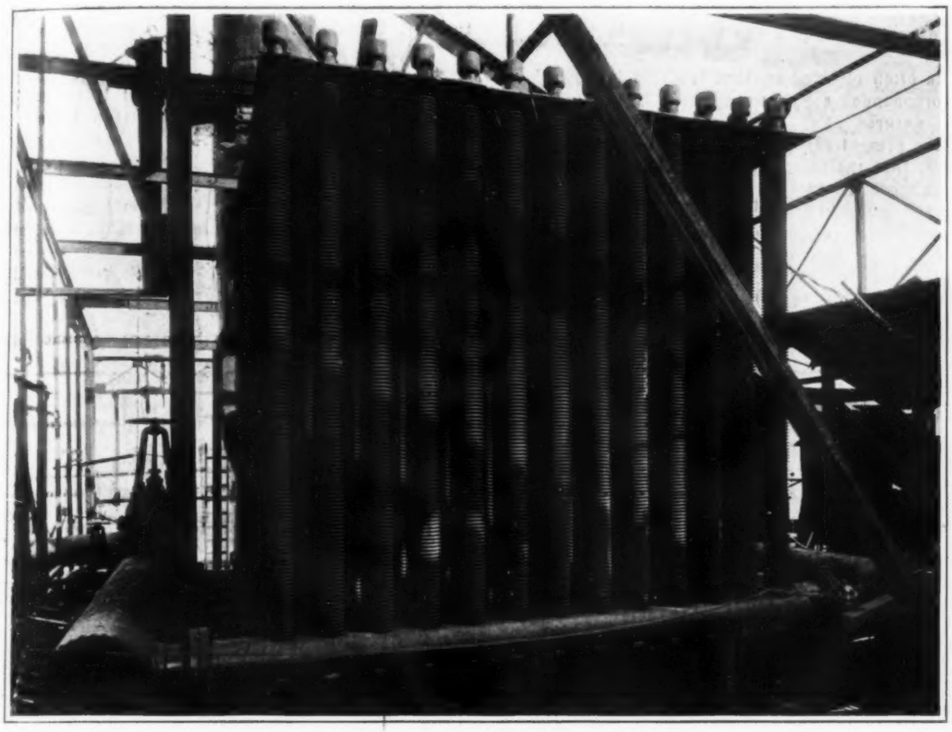


Fig. 1.—Near View of the Great Superheater.

The general arrangement and connections may be gathered from drawing Fig. 2. The superheater is of Foster construction, made up of 306 elements or superheater tubes 12 feet long and arranged vertically in seven banks, one behind the other, giving an arrangement 18 elements deep by 17 elements wide on an average. At the top the elements are expanded into steel return headers and at the bottom into wrought steel connecting headers. There are 14 headers, seven connected to the inlet and seven to the outlet manifold, so that the steam passes from the inlet manifold to the inlet connecting headers, through the elements and return headers and to the outer manifold. The temperature of the steam leaving the first bank, although it comes in contact with the hottest or entering gases at about 1,250 degrees Fahrenheit, is nearly the same as the temperature of the steam leaving the last or seventh bank, where the temperature of the gases has been reduced to 450 degrees as they leave the superheater.

The last bank is arranged on the counter-current principle, thus ensuring a maximum heat, and the lowest practicable temperature for the gases leaving the superheater. This arrangement of heat-exchanging surface secures the thorough distribution of the work over the entire surface and avoids concentrating the work on the first few rows of elements. The setting is made of paneled steel plates, lined with asbestos blocks and 4½ inches of firebrick, with an air space between. The panels are removable, giving easy access to all parts of the interior. Soot-blowing and cleaning doors are provided. The superheater is erected on a platform supported on columns, over the billet heating furnaces which supply the waste gases. The hot gases are received through four brick-lined flues from the four stacks of the billet heating furnaces and pass through the superheater, which is arranged with the inlet and outlet manifolds at the bottom, one on each side. The gases are drawn through the heater by means of an electrically driven induced-draft fan, providing easy control of the temperature of the steam leaving the superheater. The induced-draft fan is regulated to pull just the requisite quantity of gas to properly heat the steam passing through the superheater. The balance of the furnace gases pass up the furnace stacks.

Steam is supplied to the heater from three different boiler houses. These stirling boilers have an aggregate capacity of 9,520 horsepower. The steam from about 8,000 horse-power of these boilers goes through the superheater, where it is superheated 100 degrees to a final temperature of 470 deg. F. The contract required that 240,000 pounds of steam per hour at 145 pounds pressure, containing 3 per cent of moisture, should be superheated 100 degrees, corresponding to a final temperature of 463 deg. F. The superheated steam is supplied to two Porter Allen compound engines and two Nordberg engines driving rod mills.

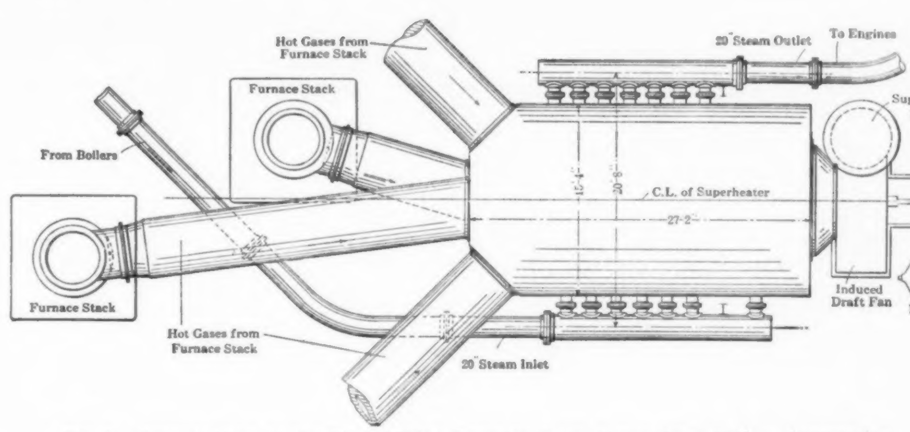


Fig. 2.—General View of the Plant Which Superheats the Steam from Boilers Aggregating to 8,000 Horse-power.

The Biology of the Savant*

A Study in the Psychology of Personality

By Wilhelm Ostwald

By one of those agreeable whims of chance which sometimes brighten the austere path of the scientific investigator, it so happens that the work to which I have especially devoted myself of late years, is connected with a book which has a close association with Geneva. I refer to the "History of Science and of Savants," by Alphonse de Candolle.

It was in this remarkable volume that I found for the first time the thought that the brilliant phenomenon we call genius may be studied by the precise methods applied to the natural sciences. This thought took profound hold on my mind until the ideas resulting therefrom took shape in a volume† some of whose reflections and observations I wish to quote and to enlarge upon to-day.

In considering this subject, the just question which presents itself is the superiority of great savants and the hereditary traits they manifest. Galton maintained with ardor that scientific aptitudes are transmitted from one generation to another. Incontestably, heredity plays some part, but the question at once arises: why do the brothers and sisters of a great man almost never attain an intellectual level at all comparable to his, though having the same parents and usually the same environment?

Without precluding other possible causes let me offer a tentative theory to account for this fact.

Contemporaneous researches on heredity have demonstrated that the qualities of the individual never represent, as one might at first suppose, an arithmetical mean between the qualities of the parents. On the contrary it is either the paternal or the maternal feature which predominates in a given instance, and if these are opposite in character one will be developed and the other remain latent.

Hence arises a mosaic of qualities which is not necessarily in harmonious accord, and is indeed frequently in more or less flagrant disaccord.

This explains why children of the same parents may be so different, and indicates, too, that occasionally a group of qualities may be combined in so harmonious a manner as to produce results which far surpass the average, and permit us to speak of genius. An ordinary man at the age—from 12 to 17—when intellectual traits first become marked, is apt to present an impression of discord, which is why we commonly speak of this period as a "thankless age."

The "born genius," on the other hand, is scarce conscious of difficulties. His various faculties act in harmonious combination, and the first result of this happy frame of affairs is that wonderful precocity which is the mark of nearly all future geniuses.

Liebig won his professorship at twenty-one.

Lord Kelvin was fourteen when he commenced his discoveries in mathematical physics, and similar instances abound in the annals of great men.

There is, to be sure, an ancient prejudice against precocity, and a belief that a slower development is of better promise for maturity. But I am of opinion that this view was invented for the consolation of the mothers of backward children. On the other hand maternal pride is always highly gratified by evidences of precocity when they do exist.

*Address given by Wilhelm Ostwald, Professor Emeritus of the University of Leipzig, at Geneva on the occasion of the recent Jubilee.

†Grosse Männer, Leipzig, 1909.

Another prejudice which observation confutes is, that early development foretells an early death. Liebig lived to be 73, Lord Kelvin is 80, both conserving their scientific aptitudes in large measure into old age.

Without doubt many geniuses die young. This, however, is not due to precocity, but because such labors as geniuses only can achieve are not accomplished without peril to life.

The biography of future savants usually shows that they were poor scholars. Inversely, it is well known that prize pupils rarely achieve anything extraordinary in after life.

These admitted facts signify simply that the current practice of the schools not only does not stimulate the future savant, but actually creates obstacles to his development.

One of our most important institutions, therefore, on which depends the worth of future generations, is organized in a manner so contrary to good sense that its methods subvert its very *raison d'etre.*

And just here we perceive the importance of those researches into life histories which may seem at first blush to yield results only anecdotal or amusing. For we shall have occasion to draw from our study of the biology of the savant conclusions of an immediate practical significance.

You naturally ask in what consists this conflict between the schools and the scientific aptitudes. We answer that the dominant qualities of an investigator—a seeker—are originality of thought and independence of judgment, and that the school systematically represses these faculties by virtue of its fundamental principles.

From that distant era when the object in view was the imparting to barbarians an already developed civilization. The schools have retained the habit of demanding from their students an entirely passive and receptive attitude. The abandonment of this attitude, the attacking of a subject of study in a personal manner was correspondingly considered a dangerous and a punishable act.

In the natural sciences we have forsaken this attitude, from mathematics to sociology, though in jurisprudence and in philology—above all, in classic philology—notable traces of it still persist.

Thus we see how this outworn idea has survived from a past era in the schools. The secondary schools, from the kindergarten to the university, are to-day under the exclusive direction of jurists and of philologists, who, as masters, directors and administrators, decide both the manner of instruction and the subjects of study.

The sciences, on which essentially depends the progress of our civilization, are either excluded from the schools or so restricted as to exert no influence.

Even in establishments which boast a special attention to science, ancient and modern languages, especially in Germany, occupy at least half the available time.

But the natural languages with their capricious laws and exceptions are a wretched and an illogical medium of cultivation. We can perceive daily how much of fortuity there is in the new formations of a living tongue, and the influence every factor except logic exerts upon these formations. But the ancient forms, which we are invited to regard as sacred and untouchable elements of human knowledge, were produced in the same manner as the modern.

It is not, then, matter for wonder, that the mind of the future scientist rebels against such senseless and capricious tyranny.

Are not the characteristics of such a mind of a nature that it directs its attention to the essence of things and not to the words which are but the accidental envelop, and that it desires to penetrate in independent fashion the realm of the unknown in place of accepting passively the already known?

But is this conflict between the school and the budding scientist a fatal one? The nature of the latter cannot be altered without destroying it. Can the school be so reformed as to cease the destruction, or at least, the obstruction of the scientific temper? I answer "Yes," and the response is dictated by the facts observed regarding exceptional men.

One marked trait characterizes savants—it is that they consecrate their interests and their activities in a very definite and exclusive manner to precisely determined objects, while other fields engage them only in so far as they impinge upon the original matter under investigation.

All that the future scientist demands of the school is that it must supply him with means of learning and of working in the domain to which his gifts impel him, and that it shall not force him to waste precious time on other things whose relation to that in which his interests center, he does not perceive.

But the school censures this attitude as blamable. It demands of its students that they do equally well in all branches, and forces those whose gifts unmistakably indicate a certain bent, to devote the best of their time and effort to subjects which do not appeal to those gifts, and in which, therefore, the results obtained do not reach the level exacted by the school.

Every master perceives, when his eyes are once opened to this fact, that these efforts of the school are habitually without success, and lead to those constant conflicts between masters and pupils which exhaust innumerable energies.

Nevertheless the ideal of "harmonious culture" remains intact, and it is only of late that this emptiest of pedagogic principles has been seen to be impracticable.

It is often objected to, that the principles we have just propounded are of weight only for exceptionally gifted natures. For the average man it is claimed that the present system secures the best results. We answer, that the most rational method of instruction is even more valuable proportionally for the mediocre than for the gifted man—the latter might succeed, at the worst, in breaking his own path. And on the other hand to obstruct the faculties of a superior individuality—to destroy great men in the germ—for which modern schools are often responsible, is for any nation or any society whatever, a loss so great that it should be avoided at all costs. Even if individualization of instruction resulted in injury to the less gifted, it might be well worth the sacrifice. But since, on the contrary, this practice commends itself from every point of view, the sooner it is adopted the better.

Let us now inquire how young scientists acquire the knowledge of which they have need for their labors. For the greatest genius must needs start from the point attained by his predecessors. We answer in two words:—From books.

In nearly every instance we find that the young savant has procured access to a scientific library, sometimes through an older friend, sometimes in another manner, Faraday seeing no other way to attain his ambitions, became a bookbinder that he might read the books he bound.

Here is another hint of practical value. It is of the gravest importance to make this means of scientific culture as accessible as possible.

It is not enough to found libraries. It is necessary, by means of lectures and bibliographic lists, to instruct those eager for knowledge in the best methods of utilizing their treasures. And this is by no means so easy as it sounds!

When the young scientist has actually begun to create and to produce, it is interesting to observe how his labors are distributed throughout his life. One is tempted to believe that an increase of value is constant, at any rate till the approach of old age causes a general diminution of vital functions.

But a precise study of the matter leads to very different conclusions, as Tigerstedt has already shown. The most precious productions of great men are generally those of youth, and even of a remarkably early youth. In other terms, the highest point of the arc they describe is attained in a few rapid strides; after that the line curves downward, sometimes slowly, sometimes brusquely. This second portion of the arc is governed by conditions which we will presently examine.

Let us first answer the question: To what is the rapid ascension of the arc due? It arises in part from that precocity of genius which we have already affirmed, and in part from the fact that the boldness of conception and energy of endeavor which are necessary to an eminent result, are qualities of youth and not of maturity.

One may describe a normal life by saying that every being receives at birth a definite quantity of "vital potential." By which I mean the ability to assimilate and to transform energy.

The value of the resultant work depends partly on the quantity of vital potential at disposal, and partly on the degree of development of the young organism. Consequently the supreme productive aptitude coincides with the moment when maximum development is reached—i. e., from 20 to 25 years of age.

In actual fact we observe an extraordinary number of achievements of the first rank belonging to this period.

Among the scientists—Carnot, Mayer, Jowle, Helmholtz, Clawsius—to whom we owe the discovery of the most important of all the laws of nature which the last century revealed to us, namely, the laws of energy, not one was more than 28 when he published his *chef-d'oeuvre.*

Obviously they had conceived their great hypotheses, which evidently preceded their publication by some years, at the age of 25 or less. It cannot be asserted that all major discoveries come at this period, but it is certainly true of the great majority.

The effects of a discovery of this kind on the contemporaries of a man of genius vary considerably. If the new idea is far in advance of its age it has at first no effect whatever. The young savant, after having, at the cost of a tremendous effort, given birth to his thought, has before him labors not less severe to open the way for its acceptance.

If he finds in his environment lack of intelligence or positive opposition, this single discovery may exhaust the capacity of his organism for production. The unhappy benefactor of humanity, if he does not die from the results of this physical and moral exhaustion, may remain a crippled spirit for the rest of his days. This is of course the most unfavorable case as far as the effect of the discovery upon its author is concerned.

At the opposite extreme, the conditions are the most favorable possible when the new idea is but little in advance of its time, so that it is at once comprehended by some minds, and soon by many; and when, moreover, the discoverer has the assistance of friends and collaborators in the work of propaganda and popularization.

He can then pass through this difficult period without lasting injury, and produce later many admirable works. But it is very rarely that he attains a second time the level of his just achievement; and this indicates that the inevitable loss of vital potential is not compensated for by progress in practice.

The destiny of those who have not brought forth a work of the first order runs more smoothly. They suffer neither so great an exhaustion of their powers in the first instance, nor have so much trouble in gaining recognition.

Thus their life, having early attained its zenith, is filled by a series of works of about equal value, which may continue to an advanced age with a diminution only in quantity and not in quality.

We may further distinguish two extreme types among men of research, according to the habit of mind—those of rapid reaction and those of slow reaction—the more important the work the more marked being the difference.

For the sake of definiteness, let us call the first the romantics, the second the classics. Liebig and Helmholtz will serve as respective examples.

The romantics are characterized by an exceedingly prompt and abundant flow of ideas and projects. This usually makes them admirable masters, who inspire with their own enthusiasm and ardor many pupils. They are the founders of schools and determine methods of work for many other minds.

The classics produce slowly and with laborious effort, but they give birth to results which evidence much longer without change than do those of the romantics. Their method of production makes them reserved and retiring men, little disposed to immediate personal action. They are apt to make poor teachers, and the best they can arrive at as instructors is a carefully prepared course of lectures, to which one listens as to recitations from a book. They lack that fire of enthusiasm which kindles even the indifferent. On the other hand the classic perfection of their achievements offers treasures of instruction to the more advanced of their students.

It is easy to distinguish these fundamental traits in the life and the methods of any given great man. And these characteristics appear so early that we have the right to demand of authorities, faculties, senates—of all in short who preside over schools and universities that they take account of these gifts in nominations to the faculty or in the distribution of existing forces.

Thus the best results may be derived from the diverse abilities of both romantics and of classics.

Age is also an essential factor in questions of this kind. We have seen that the *chef-d'oeuvre* is usually the product of youth; the history of great teachers shows that their aptitude for the organization of a school, in the best sense of the term, is likewise limited to the first half of life. The great devotion they display early exhausts their powers. This is a reason the more for early giving opportunity for vast activities to a man of genius of the romantic type.

A university desirous of renown through the brilliance of its scientific achievements should use every endeavor to discover young geniuses of the romantic type.

Generally their youth makes them accessible and their pretensions are modest. At the same time care should be taken to suitably engage the faculties of men of the classic type, and especially to facilitate production, which to them is always laborious.

These considerations bring us naturally to a final question: What should be the fate of aged savants who have rendered great services, and who have paid the penalty of their exceptional faculties by the loss, more or less complete, of their productive powers? The problem is complex, but the most approximate solution would seem the creation of honorary professorships, which, while providing proper emolument, would exact nothing but residence in the university or in its vicinity.

A man who has produced a great work is thereby raised to a superior level. His presence is a living

obstacle to laziness and indifference on the part of his colleagues. The personal contact with his younger fellows would give opportunity to plant in the most fecund of soils the seed of his own experience and knowledge of life. Thus the closing years of his career would be harmonious and agreeable, and both he and the community would fitly profit by his high intelligence.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT, from La Bibliothique Universelle.

Manufacture of Cocaine

The Chemical Preparation of An Important Drug

THE coca leaves, from which cocaine is extracted, contain too little of this precious alkaloid (about one-half per cent) to permit of their shipment over a long distance to extracting factories in Europe or the United States. As a matter of fact, a sea voyage is objectionable also for this reason that the leaves would lose a great proportion of their cocaine, owing to the fermenting action which occurs.

The coca plant grows in the highlands of Peru, and can be transported from there only over mule paths; accordingly, the cocaine is extracted on the spot. The process employed, although rather old, is far from being primitive. At any rate, it gives the best results that can be reasonably expected in view of the very limited means over which the country disposes, as has been pointed out by "*The Engineer*," from which the description here given has been gathered.

It may be well, first of all, to briefly recall some of the properties of cocaine.

Properties of Cocaine. Cocaine ($C_{17}H_{21}NO_4$) occurs in the coca leaf, together with a number of other alkaloids resembling it in physical and chemical properties, but possessing none of its anesthetic properties, and being, therefore, quite useless.

Cocaine is a solid, melting at 98 degs. C., and fairly soluble in hot water, though scarcely soluble in cold; readily soluble in alcohol and in ether. When the aqueous solution is evaporated, the residue obtained is no longer the pure base, but is found to have undergone initial saponification, being transformed into benzoyl ecgonin ($C_{16}H_{19}NO_4$). This transformation is readily understood, for it has been known since Wöhler's time, that cocaine is decomposed by hydrating agents into benzoic acid, methyl alcohol and ecgonin, according to the reaction:

(1)

$$\underset{\text{cocaine}}{C_{17}H_{21}NO_4} + \underset{\text{water}}{2H_2O} = \underset{\text{benzoic acid}}{C_7H_6O_2} + \underset{\text{methyl alcohol}}{CH_4O} + \underset{\text{ecgonin}}{C_9H_{15}NO_3}$$

In analogous manner, benzoyl ecgonin, an intermediate product, which is also present in the coca leaves, splits up upon hydration into benzoic acid and ecgonin.

(2)

$$\underset{\text{benzoyl ecgonine}}{C_{16}H_{19}NO_4} + \underset{\text{water}}{H_2O} = \underset{\text{ecgonine}}{C_9H_{15}NO_3} + \underset{\text{benzoic acid}}{C_7H_6O_2}$$

The inverse reactions also are possible. The reaction (1) has served as a basis for researches towards the synthesis of cocaine; the inverse of reaction (1) has in fact been realized by Merck in the laboratory, but the yields were poor. A little later the reaction was successfully carried out industrially by Liebermann and Giesel, whose processes, as we shall see presently, have been used in Germany to extract pure cocaine from the crude material shipped from Peru.

Cocaine is used almost exclusively in the form of the hydrochloride $C_{17}H_{21}NO_4 \cdot HCl$; this salt being very readily soluble in water and crystallizing well.

Extraction of the Crude Cocaine in Peru. This extraction, which is carried on in one building, shown in the figure, comprises three operations; (1) Maceration of the leaves; (2) Precipitation of the cocaine; (3) Purification of the same.

The macerating plant contains four basins, *A*, *B*, *C*, *D*, in which the coca leaves are submitted to methodical maceration in water containing five grams of sulphuric acid per liter. The vessels *E* are used for preparing this acidulated water. The leaves remain four days in each of the vessels, *A*, *B*, *C*, *D*. Every twenty-four hours the liquid from one basin is transferred to the neighboring basin whose charge of leaves is twentyfour hours younger, and the basin thus emptied is replenished with the liquid from the other neighboring basin containing a charge of leaves twentyfour hours older. The leaves which have been almost completely extracted, after three days' maceration, are finally treated with pure acidulated water in which they are left for twenty-four hours. On issue from this they are discarded. The concentrated liquor is conveyed to a filter *S* which arrests dust and other foreign matter, before the next step, the precipitation, is undertaken.

This precipitation is carried out in the vessels *T*, in which there is added to the liquid a solution of sodium carbonate registering sixty degrees *B.* prepared in the kettles *Z*. In this way solid cocaine is precipitated. The precipitating process is controlled by taking out a sample of the turbid liquid, filtering, and testing the filtrate with ammonia. If all the cocaine has been precipitated, the ammonia gives no further precipitate.

After this, petroleum from the reservoir *L* is introduced and the liquid is agitated (gently, in order to avoid undue contact with air, which would cause loss of cocaine). The result of this operation is that the cocaine is taken up by the petroleum. This latter is then drawn off, and conveyed to washers *F*, in which it is agitated with water until free from acid.

This petroleum is then treated with water containing three grams of sulphuric acid per liter, whereby the cocaine is redissolved. The liquid is vigorously agitated for thirty to forty minutes, it is then allowed to stand fifteen minutes, and an acidulous water containing the cocaine is drawn off and sent to the reservoirs *V*. The petroleum can be used over again.

In the purifying plant, the acid solution thus obtained is treated, as was the original solution, with a solution of sodium carbonate prepared in a kettle *M*. It is then allowed to stand for twelve hours and passed through a filter *X* which collects the cocaine. The precipitate is washed with distilled water to eliminate the last traces of sodium carbonate, and the material is then passed on to the filter press *P*. From this the crude cocaine is drawn in the form of a paste containing eighty-seven to ninety-three per cent of pure cocaine. This operation is carried out only once a day. In a plant of this sort the daily output is about one kilogram (two pounds) of cocaine.

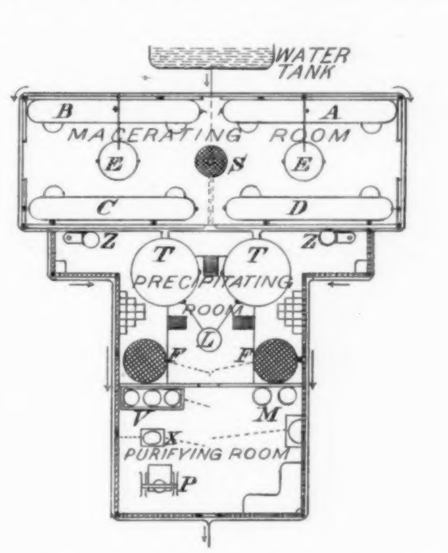


Diagram Showing the General Arrangement of a Cocaine Extracting Plant.

If the paste from the filter press is brown in color, which indicates the presence of resins, the purification is repeated by the means just indicated, finally dissolving in water containing ten grams of sulphuric acid. This new treatment gives a lighter product, but causes a considerable loss of cocaine.

Purification of the Cocaine. In France it is customary to convert the crude cocaine into its hydrochloride. For this purpose it is dissolved in dilute hydrochloric acid, and the solution is treated in the cold with a solution of potassium permanganate, which destroys the major part of the alkaloids which accompany the cocaine, before appreciably attacking the cocaine itself. This latter is then precipitated by means of sodium carbonate, and the precipitate is taken up with ether. The ethereal solution is evaporated to dryness, and the residue is dissolved in acetone, and then treated hot with an ethereal solution of hydrochloric acid. Upon cooling cocaine hydrochloride is deposited in beautiful crystal plates.

In Germany advantage is taken of the fact that the impurities of crude cocaine are ecgonin salts, and these are converted into cocaine, thus increasing the yield. We saw above that according to reaction (1), cocaine may be regarded as derived from ecgonin by methylation and benzoylation. Hence, the ecgonin is extracted and subsequently transformed into cocaine.

The process is that employed by Liebermann and Giesel. The crude cocaine is converted into ecgonin by boiling for one hour with hydrochloric acid of density of 1.1 to 1.2. There is thus formed soluble ecgonin hydrochloride, which after cooling is separated by filtration from the aromatic acids. This salt is purified by repeated crystallizations. It is dissolved in methyl alcohol, and the solution is saturated with hydrochloric acid gas. There is thus formed methyl ecgonin hydrochloride, which is precipitated with ether. This product, upon treatment with benzoyl chloride, yields methylbenzoylecgonin hydrochloride, which is nothing more nor less than cocaine hydrochloride. The cocaine is precipitated with sodium carbonate, and is transformed into its hydrochloride, which is the salt put on the market.

The Sick Pearl Necklace of Madame Thiers

THE superb pearl necklace that formerly belonged to Madame Thiers, wife of the famous French diplomat, which she bequeathed to the French nation, and which is kept in the Louvre, is perishing of the peculiar, mysterious disease that attacks pearls. The necklace consists of 150 of the most magnificent pearls ever brought from the depths of the ocean. When Madame Thiers willed it to the French people, it was valued at $250,000, but to-day probably few jewelers could be found willing to give $25,000 for it, to such an advanced stage has the disease attained. Experts are puzzled to find an explanation for the cause of the disease, but it is probably a form of starvation. It is as though the pearls find nourishment in the life that is seated in the skin of beautiful women, for which reason jewelers maintain that pearls must be worn on the bare skin. According to the will of Madame Thiers, her necklace cannot be taken from its case in the Louvre. If it were possible at some time to loan it to a lady possessing the confidence of the French government to a sufficient extent, a majority of the pearls, in the opinion of all the experts, would recover. This is impossible and the necklace therefore must perish. Day after day, the pearls are becoming darker in color, more unsightly and shrivelled. The disease of pearls has been known in the East for centuries; the Occident learned, only recently, that such a disease existed. There are women who cannot wear pearls, there being something about them antagonistic to the pearl. For similar reasons others cannot wear turquoise, for with them, the pretty turquoise rapidly darkens to a dirty, soapy green. There are women on whom the opal sparkles in all its iridescent glory, while the same stone, on the neck of another, will look as lifeless as a lump of clay. Pearls have often been restored by sinking them in the sea. The Queen-Mother Alexandra of England is an enthusiastic lover of beautiful pearls. Her collection is the most valuable in the world. When she is arrayed in the full glory of her pearl jewelry, the pearls she wears are valued at $2,000,000, and it is more than likely that the pearls she has and is not wearing are worth another $1,000,000. Not long ago, one of her necklaces showed signs of discoloration and the characteristic disease symptoms. The necklace was intrusted to a jeweler, who secretly sunk it in the sea. For three months watchmen guarded it night and day and when it was brought up it was said to be completely restored. It is furthermore an historical fact that when the late Empress Elizabeth of Austria was attacked with typhoid fever, her pearl necklace became discolored. It was sunk in the Adriatic Sea and guarded by a government vessel. The pearls still lie there and are examined once every year. Experts are of the opinion that years will elapse before the pearls are again restored.

Headless Butterflies

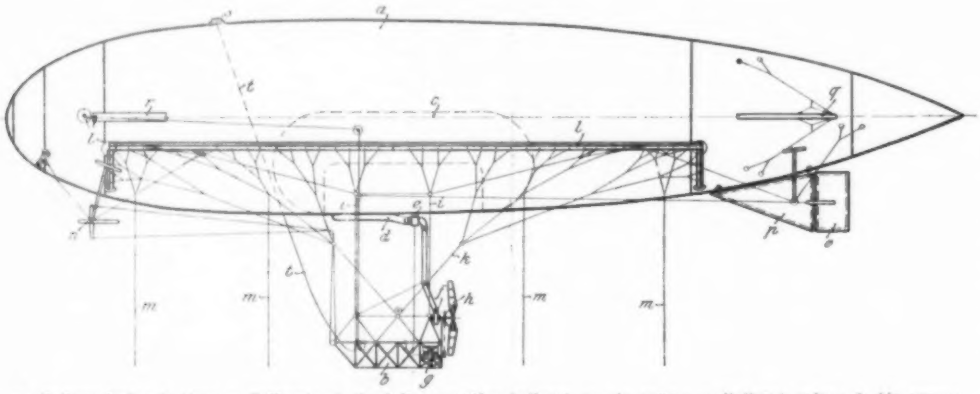
IT would seem a paradox to state that a caterpillar could live when its head was taken off, and what is more, develop into a butterfly. However, we have it on the authority of Prof. Vianney of the Lyons University that such is the case. His results were presented to the Académie des Sciences not long since. After taking a number of precautions he removed the head of several insect larvæ, and observed that this decapitation did not prevent the larvæ from going through the stages of metamorphosis into the butterfly. In the case of the Bombyx, the butterflies arrived at their mature state, with streaked wings, of very fine color, but without a head, and lived for some time.

The Sporting Airship "Parseval V."

A Three-passenger Craft

By Our Berlin Correspondent

The "Parseval V." is a dirigible balloon constructed on the well-known pattern which its name denotes, by the Motor Airship Development Company (Motor-Luftschiff-Studiengesellschaft) of Berlin-Reinickendorf, to whom should be given credit for having developed this type to its present efficiency and safety of operation.



a, Balloon body; b, Car; c, Ballonet; d, Conduit connecting ballonet to air pump; e, Ballonet valve; f, Air pump; g, Motor; h, Propeller; i, Parallelogram ropes; k, Sliding ropes; l, Belt; m, Lifting rope; n, Elevation rudder; o, Side rudder; p, Vertical stabilizing surface; q, Horizontal stabilizing surface; r, Emergency valve for rapid discharge; s, Gas valve; t, Valve rope.

Fig. 1.—The "Parseval V."

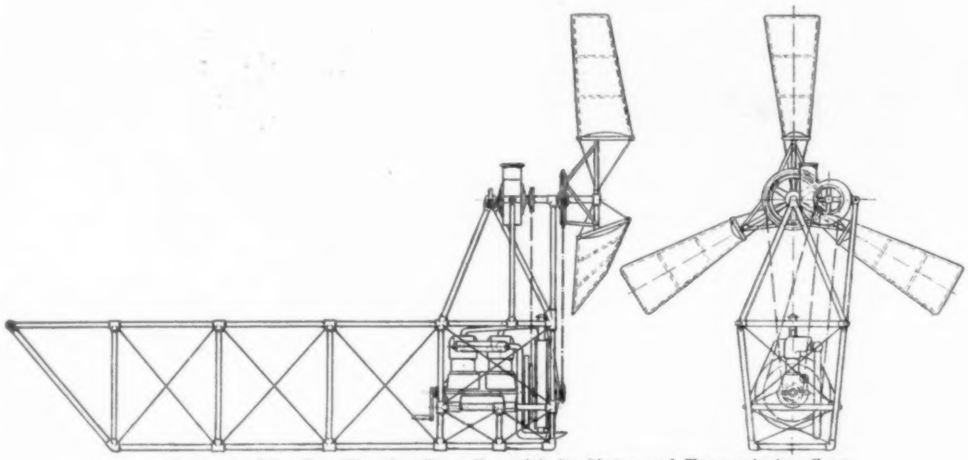
The original intention had been to design a dirigible balloon of the smallest dimensions compatible with the system. While according to theory it would have been possible to reduce the dimensions considerably farther, the miniature airship thus obtained would have been a mere toy, devoid of any practical value, so that the plans were finally drawn up for an airship carrying three persons and a sufficient amount of ballast for a six or seven-hour run at a speed of not less than 20 miles per hour.

The "Parseval V." thus constitutes the smallest of its class, and is mainly intended for the use of private parties and aeronautic clubs.

The airship is 129 feet in length and 25.3 feet in maximum diameter, its displacement being 42,000 cubic feet. The cover is made of lined balloon fabric of a minimum strength of 730 pounds per foot, and weighing 1 ounce per square foot. The balloon is made up of a number of longitudinal sections, a construction which reduces somewhat the frictional resistance of the surface.

From Fig. 1 can be gathered the general character of the airship, which has the characteristic Parseval shape, rounded off elliptically in front, and tapering to a slender point in the rear. A distinctive feature wherein it differs from all the remaining airships of the same type is that the vertical steering is effected not by two ballonets, but by a horizontal rudder located at the head of the balloon and actuated from the car through rope transmission and hand wheels. This has given excellent results, imparting to the little airship sufficient mobility and maneuvering capacity to enable it to operate at only a few yards above the ground.

A central ballonet, blown up with air from a centrifugal pump until its walls exert a sufficient pressure on the gaseous contents of the balloon, keeps its surface taut. A safety valve inserted into the conduit connecting the ballonet to the pump prevents any excessive strain being produced in the balloon cover. This valve opens automatically at a pressure of 0.6 inch of water, allowing sufficient air to escape from the ballonet for the normal pressure to be re-established. The gas valve which is located at the summit of the balloon cover is likewise designed as safety valve. As, however, this valve is not actuated until an excess of pressure of 1 inch of water is reached, there is no chance of gas losses occurring unless the expansion of the gas has forced all the air out of the ballonet. Both of these valves are connected by cords with the pilot's stand, whence they can be operated by hand.



Figs. 2 and 3. Car, Showing Propeller with Its Motor and Transmission Gear.

By means of a special device the balloon can in an emergency be emptied very rapidly. This device consists of a narrow strip of balloon fabric glued over a long cut in the balloon cover. Ordinarily this slit is kept securely closed, but when necessary it can be ripped open at a moment's notice.

At the rear end of the balloon are located the stabilizing surfaces and the side rudder. The stabilizing surfaces for the sake of appearance and lightness, have been given a triangular shape. The frames are made of steel tubes welded together by the autogenous process, and over these frames is stretched light balloon fabric, provided on both sides with vent-holes through which air is forced into the interior of the lining when the balloon is in flight, thus keeping the material taut and smooth.

The car which is diagrammatically represented in Figs. 2 and 3 is built of steel tubes and is 39 inches in height, 14.75 feet long and 2.79 feet and 2.13 feet broad at the top and bottom respectively. Though the normal number of passengers for the balloon is three persons including the pilot, the car will accommodate four persons, the pilot being posted in the fore part where the two hand-wheels for controlling the elevation and side rudders are located side by side. As the cords for operating the gas and ballonet valves also terminate there, the airship can be readily controlled by one man.

All the mechanical parts such as the motor, radiator,

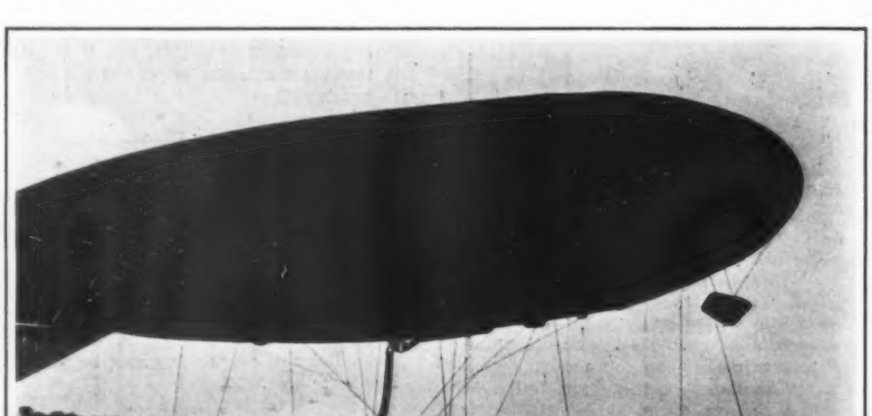


Fig. 4.—Rising from the Ground.

THE "PARSEVAL V."

propeller, and air pump are arranged in simple and compact order in the rear of the car.

The engine is a 25-horse-power 4-cylinder Daimler motor, performing about 1,200 revolutions per minute, and using up at full load about 0.54 pint of gasoline per horse-power hour. This motor is fitted with a Mercedes piston-valve carbureter, ignition being effected by a high-tension magneto. The fly-wheel is designed as radiator fan and at the same time as belt pulley for operating the ballonet air pumps. The radiator is placed behind the motor and is traversed by the main driving shaft which also has bearings behind the radiator. The propeller is driven by a pulley chain geared in the ratio of about 4:1, and is located on a jack above the motor, upon which the ballonet pump is also mounted.

The three-vane flat propeller is 9 feet 9 inches in diameter and as distinguished from those of earlier Parseval airships, its vanes are semi-rigid, being constructed of a framework so pivoted at the base as to prevent strains liable to result in rupture of a vane. The fundamental principle of the propeller has for the rest been kept unaltered.

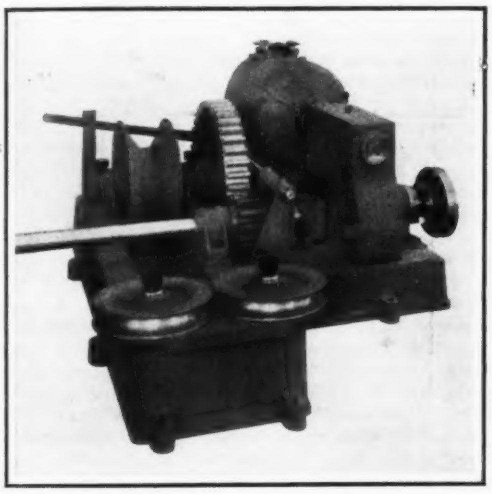
The suspension of the car is analogous to that of the larger Parseval airships except for some alteration necessary owing to the reduced dimensions. The car is suspended by vertical parallelogram cables, which keep it hanging always in a direction parallel to the longitudinal axis of the balloon, but is otherwise free to travel in a path controlled by two idlers on sliding ropes running obliquely fore and aft. This arrangement prevents any accidental inclination of the balloon in starting under the action of the propeller, which accordingly works exactly as though its point of attack were located in the center of resistance of the airship.

A New Construction in Worm Gearing

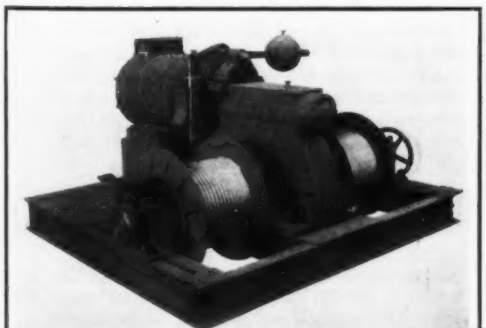
The Endless Screw as a Reducing Gear

By the Paris Correspondent of the Scientific American

On the continent a new move has been made in the use of the endless screw for different kinds of mechanical devices where a reduction of speed is required. It has been long recognized that the endless screw is one of the best means for reducing the speed of a motor, especially in the case of electric motors which generally run at high speed. However, up to the present time their use has been limited, and this is due to the erroneous idea which even yet prevails among engineers that the endless screw gearing has but a small mechanical yield and but little durability. Owing to this prejudice, to which mechanical treatises have contributed not a little, engineers were not inclined to use this kind of gearing to any great extent. A considerable sensation was made in engineering circles on the continent by the experiments carried out by Prof. Stodola in 1895 in Switzerland. Using an endless screw he was able to obtain a yield of no less than 87 per cent in some cases, this amount varying with the speed and the power employed. Since that time the attention of the large construction works was called to the matter, and one of them, the well-known Oerlikon works at Zurich, commenced to perfect the endless screw so that it could be employed in actual practice with success. Such is now the case with the new type of screw transmission which we illustrate herewith, and we are able to secure the well-known advantages inherent in this type of gearing, such as a small volume, noiseless running, great exactness in working and also the small amount of attention which is required. Owing to the success which is already obtained with this form of transmission, the matter merits attention on the part of all who are concerned in mechanical applications.



Mechanism for Transfer Platform for Railroad Cars, and the Like.



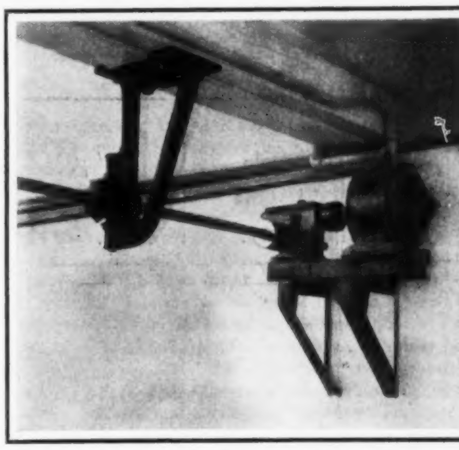
Double Cable Drum With Electric Motor and Inclosed Worm Gear.

Cable Drum.

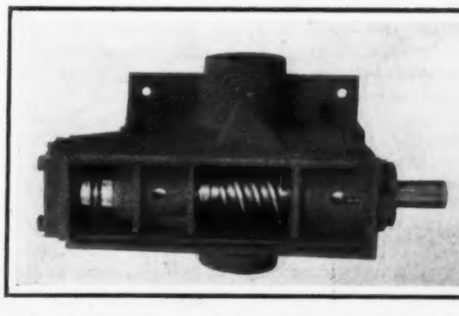
It was especially desired to obtain a good working endless screw which could be easily and economically used, and these are now made in standard types. We illustrate one of these types in detail and also show some of the various kinds of apparatus to which it can be applied. It is to be observed that in the case of the endless screw, a perfect execution in all the parts is essential if we wish to realize the theoretical conditions given by calculation. The present gears are made in special shops which are well fitted out with the proper machine tools. The ball bearings must be of the very best make, and come from recognized constructors in this line. One point, is the adjustment of the screw along with the gear wheel, and this is carried out so as to obtain an exact fitting of the gear teeth. We represent one of the standard gear boxes. One view shows the box complete with the worm at the top which is connected by a shaft to the motor. Below is the gear wheel with its projecting shaft for connecting to the apparatus which is to be driven.

The screw was formerly made of malleable iron, tempered and then polished, but it is now constructed of cast steel of best quality and finely polished. Experiment shows in fact that in the tempering, the screw often undergoes a considerable deformation, and this naturally is very unfavorable in regard to the yield and also the heating up of the gearing. One of our views represents the screw, with the top cover removed. The pressure of the teeth in the direction of the screw shaft is no longer taken by two thrust ball bearings but by a single ball bearing and this latter supports the pressure in both directions. The ball bearing is not mounted in the same compartment with the screw and gear, but is placed in a separate space, so that should one of the balls break, the fragments are not allowed to fall into the gearing and thus deteriorate the parts last named. Besides, the bearing is easy to reach. It is to be noted that the screw is always placed above the gear wheel. This has the advantage of taking less space when coupled with an electric motor, and we also have a better control of the high speed parts of the mechanism and can readily handle these parts when it is required to remove or replace them. Owing to the use of the oil box we have an automatic lubrication for all the parts, and the oil is brought by the main wheel to the screw being then projected against the top cover, falling thence to the bottom and passing by the bearings. The material employed is a mixture of two-thirds of pure lard and one-third of thick cylinder oil (black oil) with a small amount of machine oil, and this is found to give the best results.

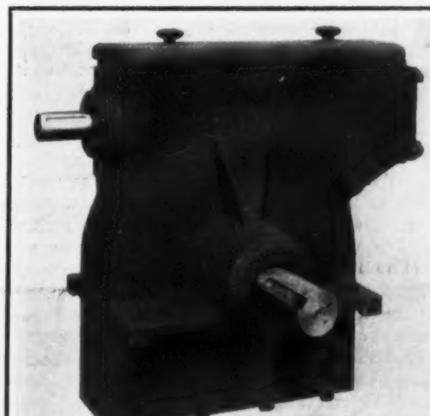
Owing to the present improvements, endless screw gearing can be applied for the most varied uses. One of the principal applications is in combination with electric motors for intermittent use such as for cranes, cable drums for mining work, elevators, capstans, rolls for iron mills, canal locks and the like. Another class which is also extensive, and which comes nearly into the class of continuous service, includes different kinds of machine tools operated by electric motors, also cloth printing machines, printing presses, etc. For continuous working we note pumps, air compressors and line shafting. We have chosen a few views among a great number in order to illustrate some of the applications which are now made. One of these is a double cable drum for mine work, with the endless screw gear mounted between the two drums. What is to be noted in all these cases is that only a single speed reduction is needed owing to the use of the endless screw, and this gives us a very compact mechanism in which all the gearing is inclosed and runs in oil. Another view shows the method of operating a pump from an electric motor, using a large pulley. We also represent an electric



Line Shafting with Motor and Standard Worm Gear Box.



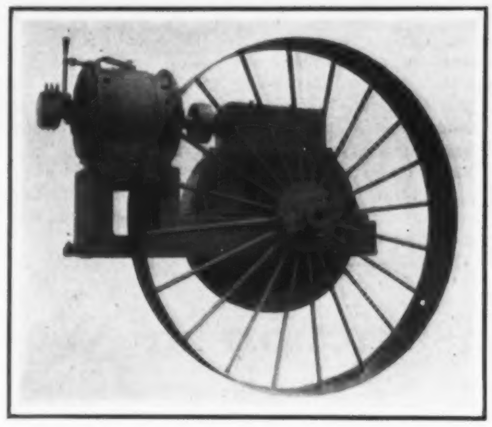
Worm Gear with Cover Removed, Shows Ball-bearing on the Right.



Worm Gear Complete—Screw at Top and Wheel Below.

drive for a transfer truck for railroad cars, etc. A second cable drum apparatus has a single drum with the worm gear mounted at one side. One of our views shows a line of shafting driven from an electric motor, and the small and well-inclosed gear system is one of the points which should bring this type into favor for this kind of work.

In order that the present method should be well appreciated, we wish to point out the following advantages which are obtained. In the first place we can use in many cases a single speed reduction with the present standard types, so that we have the most simple disposition for the gearing. It is only where a very great speed reduction is needed that we require to add an extra gear, but even in this case the endless screw cuts down the total number of gears which are required and the size is also reduced. Another point is that the endless screw allows of using high speed motors which have a small size and weight. As the screw mechanism allows of entering into all kinds of combination with the motors and the machines to be driven, the space occupied by such a construction is reduced to a minimum. The present views bear out this point. Reliable working is also obtained, owing to the fact that the speed reduction parts are less and we thus have a reduced



Pump Drive from Electric Motor by Worm Gear.

liability to accident or interruption of service. The breaking of a tooth is scarcely possible, as the teeth are calculated for a very large margin. As all the gearing runs in oil and is thus automatically lubricated, but little inspection is necessary. For regular service the oil box is filled about once a week, while once a month is all that is needed for machines used in intermittent service. The wear of the pieces and the resulting expense for maintenance are lowered, as is at once apparent from the less number of working parts. Tests in actual machines covering a long period show that the screw gear will hold out almost indefinitely. This was observed specially upon traveling cranes and also upon machine tools. In this latter case the gearing was almost continually working. An advantage which should be noted is the easy and noiseless running of such gears, and this favors their application in certain fields, for instance for cranes and elevators. This is especially to be noticed in transmissions where the direction of running is frequently reversed and here the endless screw has a decided advantage. In all cases, the noiseless running is one of the most agreeable qualities of these gears. Regarding the expenditure of power, this is a favorable point. As we already mentioned, the present gears in their perfected state have a remarkably high yield resulting from the small friction loss. Owing to the fact that one of these gear sets can be used to replace two of the ordinary straight gear pairs, we are able to secure an equal yield and even a superior one in most of the ordinary cases.

Recent Researches in the Field of Radio-Activity*

A Review of the Present State of Our Knowledge

By Prof. Henrich

The last meeting of an international congress for radiology and electronics in Brussels showed the interest which all civilized nations take in this new field of research. At this meeting the most important recent discoveries were presented and theoretical questions were discussed. Madame Curie described the preparation and the properties of metallic radium which she and Debierne have recently isolated.

The very extensive programme of the congress included the adoption of an international plan for promoting unity of work and nomenclature. The published measurements of the intensity of radio-activity are, as a rule, not exactly comparable, because they were made with various instruments and methods and with radium preparations of various degrees of impurity. It is very desirable to establish correct and uniform untis of radio-active substances, but this is very difficult because all radio-active measurements are ultimately based upon measurements of the rays. The different radio-active substances emit rays which are similar, but not identical with each other. Hence, a separate unit should be established for each radio-active substance. This object cannot be accomplished at the present time.

Most of the measurements have been made with radium. Strong radium preparations are best estimated by the activity of their Gamma rays, weak ones, by that of the emanation which they evolve. Eve has devised a method of measuring the Gamma rays by interposing between the preparation and the electrometer a plate of lead ½ to 1 centimeter thick, which absorbs the Alpha and Beta rays. The quantity of emanation has been measured by various methods. In Austria and Germany it is estimated in absolute electrostatic units in terms of the total saturation current produced in one hour by one liter of the liquid impregnated with emanation. This Mache unit, as it is called, equals one thousandth of an electrostatic unit or 3×10^{-10} amperes. Measurements made in this way with instruments of approximately equal capacity are comparable with each other and thus a satisfactory knowledge of the comparative radio-activity of the principal mineral springs has been obtained. The instrument employed for this purpose, the fontactoscope of Engler and Sieveking, gives very trustworthy results in skilled hands. The result varies with the size of the vessel, but Duane has given a correction formula which takes account of the absorption of the rays by the walls, and which depends upon the relative values of the surface and capacity. In future more exact measurements the amount of emanation in spring water would better be estimated by comparison with the quantity of emanation evolved by a definite mass of radium. In 1904 Curie and Laborde took as a unit the quantity of emanation evolved by one milligram of radium bromide in one second. Rutherford recommends as the unit 10^{-12} grams of radium.

After an introductory address on these matters by Rutherford, an international committee was appointed to consider the questions and to report during the meeting of the congress. The committee was composed of the following members: Germany, Hahn and Geitel; Austria, Meyer and Von Schweidler; England, Rutherford and Soddy; France, Mme. Curie and Debierne; United States, Boltwood; Canada, Eve. According to the provisional conclusions of the committee, which were adopted by the congress, Mme. Curie undertook to prepare as speedily as possible a unit of radium sufficiently large to allow its weight to be accurately determined (about 20 milligrams). This unit, like the standard meter, is to be kept in Paris and used only for comparison for the secondary standards of about one or two milligrams, which are to be prepared by the various nations. All future measurements of radio-activity shall be based upon these standards. No decision was reached in regard to the establishment of very small standards for the measurement of the radio-activity of mineral springs and the like. It is not yet known how long very weak radium solutions will remain unchanged without precipitation. The majority of the members favored the provisional retention of the Mache unit for measurements of the radio-activity of water, gases and the atmosphere.

In honor of the discoverer of radium it was decided that the quantity of emanation which maintains equilibrium with one gram of metallic radium shall be called one Curie. The practical unit, one millicurie, is equal to 0.001 Curie.

When it was first observed that all substances which have been in contact with radio-active bodies became temporarily radio-active, the name "induced activity" was applied to this phenomenon. It was soon found that this induced activity is due to a deposit of products of disintegration of the radio-active substance. In the case of radium, or its emanation, this deposit is a mixture of radium *A*, radium *B* and radium *C*. As we have here to do with substances and not with properties, the congress resolved to adopt the term "active deposit" instead of "induced activity."

Often radio-active products of disintegration which were first regarded as homogeneous have proved, on closer investigation, to be complex. Confusion has been caused by the adoption of new names for the ingredients of these mixtures. It was resolved to adopt numerical suffixes instead of distinct names, for example, radium *C* 1, radium *C* 2, mesothorium 1, etc.

The hypothesis of atomic disintegration has maintained its usefulness as an aid in the development of the field of radio-activity. This hypothesis is briefly expressed as follows: The atoms of radio-active substances are in a state of continuous and regular disintegration, so that in a unit of time a definite and constant proportion of the whole number of atoms becomes disintegrated. The disintegration is of an explosive character, and is accompanied by the expulsion of an Alpha or a Beta particle. Alpha particles are simply atoms of helium bearing twice the ordinary positive charge of electricity. They are expelled with a velocity which varies from one-twelfth to one-thirtieth of the velocity of light, according to the nature of the radio-active substance. They possess the power to ionize the air through which they pass, to a certain distance which depends upon their velocity. The ionization ceases abruptly at the end of this distance, or "reach," which in air varies from 2.7 to 8.6 centimeters for the Alpha rays emitted by various substances.

Beta particles are negative electrons, having an apparent mass equal to 1/1700 the mass of an atom of hydrogen. The velocity with which the Beta particle is expelled ranges from three-tenths to nine-tenths of the speed of light, according to the nature of the disintegrating element.

The expulsion of Alpha and Beta particles from the radio-active atom has been compared with the discharge of a projectile from a gun. In the latter case the gun recoils in a direction opposite to that of the projectile, and the velocity of the recoil can be computed from the law of the conservation of the center of mass. In like manner the residue of the exploding atom must recoil in a direction opposite to that of the expelled Alpha particle. This recoil is probably the cause of the active deposit formerly called "induced activity." The disintegrating atom of emanation experiences no great resistance to the recoil in a gaseous medium, so that it is hurled violently against the nearest solid object, to which it adheres.

Many radio-active substances also emit Gamma and Delta rays which will be described presently.

The different radio-active bodies are characterized by the rays which they emit, for although these rays are generally believed to consist in all cases of doubly charged helium atoms, or Alpha particles, and of electrons or Beta particles, their velocities vary according to the substance which emits them, while the velocity of the Alpha rays (or the Beta rays) emitted by any given radio-active substance is always the same.

Great progress has recently been made in the study of the Alpha rays. Rutherford and Geiger, as well as Regener, have devised methods of counting the Alpha particles, and the number of such particles emitted by various radio-active substances has lately been studied. It was first assumed that, in the explosive disintegration of the atom, only one Alpha particle is expelled. Bronson showed, long ago, that this assumption is not in harmony with the observed facts in the case of actinium and thorium. This conclusion has recently been confirmed by Geiger and Marsden, whose experiments make it very probable that a disintegrating atom of actinium emanation expels two Alpha particles simultaneously. In the disintegration of thorium emanation four Alpha particles appear to be expelled, but not simultaneously.

Rutherford and Geiger have calculated the numbers of Alpha particles expelled by uranium and thorium and by uranium ores. They find that one gram of radium, or a quantity of any of its disintegration products which remains in radio-active equilibrium with one gram of radium, emits 3.4×10^{10} Alpha particles in each second. Now one gram of uranium remains in equilibrium with 3.4×10^{-7} grams of radium, hence if each uranium atom expels only one Alpha particle, one gram of uranium must expel 11,600 Alpha particles per second. Let *N* denote this number. Boltwood has found, however, that the Alpha activity of uranium is twice as great as that of the equilibrating quantity of radium, hence uranium must emit 23,200 Alpha particles per gram per second. A uranium mineral in which the uranium and its whole series of disintegration product are in equilibrium must emit 8*N* Alpha particles per second per gram of uranium, namely 2*N* particles from the uranium itself and 6*N* from its six successive products, including polonium. This number 8N, however, is still too small, because every

* Abridged translation from *The Zeitschrift für, angewandte Chemie.*

uranium mineral contains actinium, having an Alpha activity equal to 17 per cent of that of the uranium. From these considerations the number of Alpha particles emitted by a uranium mineral is computed as $8.34 X = 9.7 \times 10^4$ per second per gram of uranium.

From an actual count of the Alpha particles by the scintillation method, the number emitted by Joachimsthal pitchblende per second per gram of uranium is estimated to be 9.6×10^4. This is a surprising agreement between the results of calculation and observation. Both investigators found that one gram of thorium in equilibrium with its disintegration product emits 2.7×10^4 Alpha particles per second. From this it follows that one gram of thorium evolves 3.1×10^{-5} cubic millimeters of helium annually.

New measurements by Hahn have shown that the reach of the Alpha rays is greater for short-lived than for long-lived radio-active substances. In gases the reach is inversely proportional to the pressure. The absorption per molecule of gas traversed is proportional to the sum of the square roots of the atomic weights of the elements composing the gas.

A peculiar appearance, first observed in brown mica, is caused by Alpha rays. This mineral sometimes shows small colored spots surrounding minute crystals of zirconium or apatite which, according to Strutt, are rich in radium. These crystals emit Alpha rays, which are known to have a reach in mica of about 4/10 millimeter; this corresponds to the average radius of the observed spots. Rutherford has succeeded in producing an analogous phenomenon in glass, by filling a capillary tube of sodium glass with radium emanation. Microscopic examination, a month later, showed a reddish coloration which penetrated 0.039 millimeters into the glass. The calculated reach of Alpha rays in glass is 0.041 millimeters.

The Beta rays have proven less tractable. No simple law of absorption has been found for them, although many investigations have been made. Schmidt has given a formula which contains, in addition to the atomic weight of the absorbing substance, two characteristic constants, the "true coefficient of absorption" and the "coefficient of reflection." In many cases this formula agrees with the results of experiments. The recent investigations of Hahn and Meitner put the matter in a somewhat different light.

In measuring the absorption of the Beta rays of various substances by aluminium plates of known thickness, Hahn and Meitner found frequently a greater absorption in the superficial layers than the exponential law demands, while at greater depths the absorption obeyed this law. They inferred the presence of several varieties of Beta rays, each of which is absorbed in accordance with an exponential law, but more or less strongly than the others. In the superficial layers all of these effects are superposed so that no exponential law applies to the absorption until all but the most penetrating variety of rays have been quenched. Hahn and Meitner assume that in these cases the radiating substance is not homogeneous. Subsequently they went so far as to assert that a strictly homogeneous radioactive substance emits only one variety of rays—homoegenous Alpha rays or homogeneous Beta rays. This working hypothesis has already produced results. Hahn and Meitner succeeded in analyzing radium *C*, which had been regarded as homogenous, into several constituents, and discovered thorium *D* and actinium *C*; they also discovered new Beta rays of radium, radioactinium and thorium *X*. On the other hand, they failed to decompose mesothorium 2, which should be complex, according to its curve of absorption. These results have been disputed, and the controversy has led to other important researches.

The velocity of Beta rays can be deduced from the extent to which they are deviated by magnetic force. The swifter rays are less deviated than the slower ones. If a pencil of Beta rays passes through a narrow slit to a photographic plate, a narrow blackened line is produced. This line can be displaced by interposing a magnetic field, and if Beta rays of several different velocities are present, several lines are produced, forming a sort of magnetic spectrum. The velocity of the different varieties of rays can be computed from the position of the corresponding lines. Hahn and Von Baeyer have photographed a number of these magnetic spectra. Radium E 2, which emits Beta rays that obey an exponential law of absorption and which should therefore be homogeneous, gives a spectrum consisting of a single line. The mixture of thorium *A*, *B*, *C*, and *D* contains two substances, thorium *A* and thorium *D*, which emit Beta rays, and the mixture gives a magnetic spectrum of two lines. Mesothorium 2 has spectrum of six lines and must therefore be complex. Radium and its products of disintegration give continuous spectra. They emit at least five varieties of Beta rays, and this appearance may be due to an overlapping of the various partial images. These investigations show at least the existence of groups of Beta rays of perfectly definite velocity, and thus furnish a new and valuable method of investigation.

The nature of the Gamma rays is still in controversy. In their properties they exhibit a close resemblance to Roentgen rays. Some physicists regard them, like the Roentgen rays, as electro-magnetic disturbances in the ether, differing from rays of light by the absence of exact periodicity. Bragg, on the other hand, regards the Gamma rays as material in nature, and as consisting of combinations of positive and negative particles, showing no residual charge. On striking material atoms these complexes are shattered and give rise to secondary rays. Finally, the corpuscular theory of light of Einstein and Starck regards the electro-magnetic energy of a Gamma particle as concentrated in a small volume and capable of propagation only in a definite direction. Meyer, indeed, has found that radium rays possess an anisotropic character, i. e., a maximum condensation of energy in one direction.

The Alpha rays are always accompanied by slowly moving negative particles, which have been called Delta rays. Geiger finds that these rays have no photographic and very little ionizing power.

Almost all known radio-active elements are derived from thorium and uranium. Actinium is regarded as a product of uranium, with which it is always associated in constant proportion. Only the radio-active alkali metals occupy a separate place. Elster and Geitel have studied the radio-activity of these metals. They were unable to find any permanent activity in lithium, sodium or caesium. Potassium and rubidium, on the other hand, unquestionably emit Beta rays. The radio-activity of potassium was discovered by Campbell and Wood, and has been confirmed by numerous experimenters. Elster and Geitel found it impossible to deprive potassium of its activity by solution, precipitation, electrolysis, etc. Hence potassium is a primary radio-active element analogous to thorium and uranium, but it has not yet yielded any emanation or other disintegration product. The Beta rays of rubidium are more easily absorbed than those of potassium. It is remarkable that caesium, the heaviest of the alkali metals, is not radio-active.

The event of the past year is the production of metallic radium, by Madame Curie and Debierne. The object was accomplished by the electrolysis of pure radium chloride with a mercury cathode, with which the radium formed a liquid amalgam. This was carefully dried and the mercury was distilled off by heating to 700 deg. C. (1,300 deg. F.) in an atmosphere of hydrogen. Radium is a brilliant white metal which immediately blackens in the air, probably forming a nitrogen compound, rapidly decomposes water, dissolving therein. It melts at 700 deg. C. (1,300 deg. F.). Its radio-active properties appear to be identical with those of its salts. It belongs to the group of the alkaline earth metals.

Rutherford and Boltwood have made a new study of the formation of helium from radium. An enumeration of the Alpha particles emitted by radium indicated that one gram of radium in equilibrium with its short lived products should produce, in one year, 158 cubic millimeters of helium. Dewar had previously found by experiment the value of 135 centimeters. The new experimental value of Rutherford and Boltwood is 163 centimeters.

Debierne has determined the atomic weight of radium emanation from its density as deduced from its rate of diffusion through a small orifice. The advantage of the method is that it can be applied to a mixture of emanation and other gases. The atomic weight was found to be 220. Ramsey and Gray have obtained nearly the same value, 221, by weighing a small volume of emanation. The value suggested by the disintegration theory is 222.5. Some remarkable experiments have been made on the condensation of radium emanation. When a current of air containing emanation flows through a tube cooled in liquid oxygen, the emanation is condensed much more quickly and completely when the tube is composed of metal than when it is composed of glass.

The first radio-active element separated from pitchblende was polonium, or radium F. This element is very short-lived and has been obtained only in exceedingly minute quantities. A ton of pitchblende contains only 0.04 milligrams of polonium. Owing to its position in the disintegration series, polonium possesses peculiar interest, as it should, theoretically, become transformed into lead, at the same time producing helium from its Alpha rays. Madame Curie and Debierne succeeded in obtaining 0.1 milligram of polonium from several tons of pitchblende. They have not been able to prove the transmutation into lead, but have succeeded in demonstrating the production of helium, 1.3 centimeter of which were found in the gases evolved by the polonium solution in 100 days. The theoretical quantity is 1.6 centimeter. Rutherford and Boltwood have confirmed qualitatively the formation of helium from polonium.

Doelter has made an interesting study of the effect of radium and Roentgen rays on the colors of precious stones. The rays have very little effect on violet fluorspar, yellow diamonds, artificial rubies and amethysts. Blue sapphire becomes paler, bluish green aquamarine more blue, emerald greener, hyacinth and apatite violet. Very great changes are produced in blue and white sapphires, which turn yellow. Smoky topaz and rose quartz become dark brown. White, yellow and violet varieties of topaz assume an orange yellow hue. Doetler studied the action of the various rays. Rock salt, fluorspar, heavy spar and quartz were exposed during four months to Alpha rays, emitted by potonium precipitated on platinum. The only discoloration was observed at the point of contact of the polonium with the rock salt, which there became brown. The discoloration penetrated only a small fraction of a millimeter, corresponding to the reach of Alpha rays in solids. Deeper discolorations are caused by Beta rays and Gamma rays. A block of glass exposed to radium rays was greatly discolored to a depth of one-half centimeter, presumably by the Beta rays. A slight discoloration extending to a much greater depth is accredited to the Gamma rays. No change produced in the rotary power of quartz by exposure to radium rays could be proved with certainty. Here, too, a sharp demarkation was observed between a darker and a lighter discoloration corresponding in extent to the reach of the Beta and Gamma rays respectively. Doelter also examined the effect of radium rays on metallic solutions. One per cent solution of barium and calcium chloride remained unaltered. Calcium chloride solution became milky-blue, sodium sulphate solution yellow. These solutions, as well as solutions of mercury chloride, are colored by radium in the same manner as the corresponding solid salts.

Duane has made an interesting research on the energy of radium rays. Radium emanation was inclosed in a metal capsule with a mica window, which allowed the Alpha rays to pass, but these rays could be cut off by shutters of aluminium. A calorimeter on which the rays fell showed an evolution of heat, which ceased when the Alpha rays were cut off, although the Beta and Gamma rays still reached the calorimeter. The Alpha rays were found to possess a measurable amount of energy even at the end of their reach, or limit of ionizing power.

Some interesting physiological effects of radium rays deserve brief mention. The claim that radium emanation exerts a favorable action in gout has been confirmed by recent researches of His. Sodium urate exists in two modifications, one of which is more soluble than the other. In gout the insoluble variety is deposited in the joints. His found that radium emanation possesses the power to convert the insoluble to the soluble form. The emanation is best applied by inhalation.

Hertwig has made remarkable observations upon the action of the radium rays on eggs of amphibia. The fertilized eggs, in early stages of development, were exposed to the radiation for longer or shorter periods. The effect, always injurious, became apparent only after a long interval, and varied with the stage of development and the time and intensity of radiation. The injured cells lost their power of recuperation, but they did not die. The cells which should develop into nerve ganglia and muscular fibers were most affected, while those which develop into the so-called vegetative tissues (intestines, glands, etc.) showed greater resistance. Thus were produced monsters destitute of nerves and muscles but otherwise normal. Microscopic examination showed that the nucleus was more injured than the protoplasm.

Hertwig also applied the rays to the sperm cells of sea urchins, which retained their activity and fertilizing power after 23 hours' radiation. The fertilized eggs, however, developed abnormally.

Auer von Welsbach has extracted actinium, together with polonium and ionium, from the residues of 10 tons of pitchblende. Chemically, actinium stands between lanthanum and calcium. Its strongly radio-active and short-lived disintegration products behave like calcium, except that they do not produce insoluble sulphates.

Germany, unable to produce much radium owing to a lack of raw material, seems about to take the lead in the production of thorium derivatives. Hahn discovered mesothorium in 1907 and subsequently proved that it consists of two radio-active elements, mesothorium I and II, possessing half-decay periods of 5.5 years and 6.2 hours, respectively. Mesothorium can be obtained from the hitherto worthless residues of the thorium works. Its properties make it a good substitute for radium, especially as it is much more strongly radio-active than the latter. The activity of mesothorium salts attains a maximum in 3.2 years and then gradually declines to its original value in 10 years, and to half that value in 20 years. Chemically mesothorium and radium are so similar that it has not hitherto been found possible to separate them.

The amount of mesothorium in commercial radium salts can be estimated, according to Markwald, by heating the preparation for a short time in order to expel the emanation. After a few hours, with the decay of the radium C, the preparation should show no Gamma rays during a period of several weeks. The produc-

tion of Gamma rays in this interval indicates an admixture of mesothorium.

Elster and Geitel proved ten years ago that the electrical conductivity of the atmosphere is due to radio-active substances. The emanations of radium and thorium, and their disintegration products, have since been found everywhere in the atmosphere. According to Wilson, radium emanation is 4,000 times more abundant than thorium emanation in the air near the earth. The latter, however, disintegrates about 5,000 times faster than the former, consequently the ionizing effects of the two are approximately equal. Kurz has discovered the emanation and other products of actinium in the air.

The Alpha rays emitted by these emanations ionize the air. The atmosphere, however, is ionized to its upper limit to an extent which cannot be thus explained, nor can the ionizing of air in a completely closed vessel be caused exclusively by Alpha rays. McLellan and Wulf attribute the normal ionization of the atmosphere to the more penetrating Gamma rays, which they find adequate to produce 9 to 10 ions per cubic meter per second. Various sources have been assumed for these rays. One view attributes them to the sun, another to radio-active substances in the atmosphere, a third to such substances in the soil. This last theory is adopted by Wulf and also by Kurz, who find in the soil radio-active substances adequate to produce by their Gamma rays the 9 or 10 ions per cubic meter per second which are actually observed in the lower regions of the atmosphere. In conclusion we may note that Schlundt and Moore have found that the hot springs of the Yellowstone National Park possess great radio-activity due to the emanations of both thorium and radium.

Wireless Telegraphy and the Aeroplane

SOME very conclusive experiments were made not long since in the way of sending wireless messages from aeroplanes, by Capt. Brenot, of the French military wireless corps. The officers have been engaged in experiments of this kind for several months past, but it has taken some time to adapt the instruments to the aeroplanes and to find out the proper methods to use. In the present tests, Capt. Brenot mounted a Farman biplane, and Lieut. Menard piloted it. He was able to send wireless messages to the Eiffel Tower station for more than an hour, and at distances varying from 25 to 35 miles. The principal question lies in the weight of the wireless apparatus. They find that they can reduce the weight of the output as low as 30 pounds, but in order to give the proper support to the instruments on the aeroplane frame a large number of pieces are needed and these weigh almost as much as the apparatus, or 24 pounds, so that the real weight carried by the aeroplane is 54 pounds. The wire which serves as the aerial is mounted on a drum, and it can be unrolled so as to hang down in the air once for all during the flight. This wire is made about 400 feet long. After unrolling the aerial wire, Capt. Brenot can vary the length of the waves given by his instruments as well as the power which they represent. Current comes from a small dynamo, this being driven by the 50 horse-power motor of the aeroplane. There is here a number of difficulties in carrying out the tests under these conditions, as the pilot is very much hindered in his movements by the numerous high tension wires which surround the two passengers in the narrow space available in the present types of aeroplane, and besides he had to fly at a good height, over 1,500 feet, with a heavily loaded aeroplane carrying a long wire. The motor had to supply the power for the wireless apparatus as well as for the aeroplane. The two pilots weighed together 330 pounds, and they carried gasoline and oil for a four hours trip on board. Some danger to the pilots was found during the preliminary tests, as Capt. Brenot twice received very severe electric shocks and if these had happened to the pilot the result might have been disastrous. The great weight of the aeroplane during the flights also came near causing bad accidents. In spite of these drawbacks, the experiments which were made in the region of Versailles were very successful. In one case the aeroplane flew above the forest of Rambouillet, and a wireless post within Paris was able to pick up a message sent from the aeroplane to the Eiffel Tower, when flying at 1,600 feet height. Other messages were sent to the Tower station during the flight and the farthest one came from a point at 37 miles distance. It must be added that owing to a defect in the insulation, the messages were sent by a spark which was four times weaker than the standard spark given by Capt. Brenot's apparatus, so that the officers think that messages can be sent for at least 70 miles under these conditions.

Tea-chests, Alloy for Their Lining.—The Chinese use, as an alloy for lining tea-chests, a metal foil consisting of 125 parts of lead and 18 parts of tin.

Science Notes

New Treatment of Aluminium for Soldering.—English patent of L. Maitre.—Aluminium can be easily soldered if a thin layer of iron is first deposited on the surface. Then plunge into boiling water and then in cold water. Now re-heat until the deposit has acquired a blue color, and again immerse in cold water, as steel is hardened. This treatment causes the iron deposit to adhere more strongly to the aluminium base. The film of blue oxide is now removed from the surface of the iron deposit on the aluminium by fine emery cloth and the soldering proceeded with by any regular method.—*Brass World.*

Use of Titanium.—The use of titanium which gives promise of greatest expansion is, according to a bulletin of the United States Geological Survey, in steel and cast iron. In steel it is ordinarily added in the form of ferrotitanium (containing preferably from 10 to 20 per cent titanium) in quantity sufficient to form about 0.1 per cent of the steel. Rails treated with titanium and laid in places on railroads where the wear was especially hard are said to have shown much less wear than untreated rails. Gray cast iron also is said to show beneficial effects from such treatment. Cupro-titanium is also manufactured for use in bronze and other castings containing copper. The titanium acts as a deoxidizer, much like phosphor-tin, and makes very tough castings. Another use of titanium which promises to assume considerable proportion is the manufacture of electrodes for arc lights.—*Engineering and Mining Journal.*

Rhythms of Activity Among Termites.—It is probable that there is a rhythmic character in animal activities to a greater extent than we as yet realize. Internal rhythms have been established in the course of ages in adaptation to external periodicities. But it does not, of course, follow that there is greater activity during the day. In a termites' nest, for instance, Andrews and Middleton have shown that there is about five times as much a-doing, as expressed by the traffic in the arcades, in the greatest bustle of night work as in the greatest ebb of noon. With great patience they counted the comings in and goings out. "In one case the number of termites going into the nest each hour varied from 1,702 between 1 and 2 P. M. to 8,100 between 2 and 3 A. M., while in the same case the numbers going out of the nest were 1,194 between 12 and 1 noon, and 6,820 between 1 and 2 A. M." The curves show that the termites work at all hours of day and night. Yet there are distinct rhythms in the activities of the entire community.—*Knowledge.*

The Black Scab Potato Disease in Europe.—A potato disease known as black scab is observed in some countries of Europe. It was noticed in Hungary in 1896 and in England in 1902. The disease appears to be caused by a spore which was investigated by Schilbersky, and he gave it the name of crysophlyctis endobiotica. It causes a swelling of the surface tissues and this gives rise to wart-like appearances on the potato. In England the disease has already caused considerable damage. One proposed remedy is to dip the potatoes for two hours in a solution of formic aldehyde containing 3 per cent of commercial formal. As the spores remain in the ground and thus contaminate it after the potato crop is removed, a new crop should not be planted in the same ground, as it will also contract the disease. Up to the present the malady appears to be unknown in France, and the authorities are now taking measures to prevent it from entering the country. To carry this out a new regulation has been put into effect forbidding the importation of such potatoes.

A Remarkably Fine Gas-measuring Apparatus.—Dr. Knusden, of the university of the charming city which we take the liberty of calling Copenhagen, although its proper name is Kjöbenhavn, describes in the *Annalen der Physik* a new measuring apparatus of very great delicacy. It consists of an absolute manometer for measuring gas pressure, where a delicacy is required that corresponds to only one-thousandth of a millimeter of mercury column. In looking at an ordinary barometer, one can readily see that noting a difference of height of the mercury column of only half a millimeter (1/51 inch) would require more than usually sharp eyes or instruments, even if the barometer were capable of showing it with such help. But when it comes to only a thousandth of a millimeter (1/25400 inch) that seems beyond the range of possibility. The new instrument is based on the measuring of the pressure between two plates of different temperature, surrounded by the gas, the pressure of which is to be measured. The distance between these plates must naturally be very small. For the pressure Dr. Knuden has found an absolute law. The apparatus consists of a polished copper plate, hung on a thin platinum wire, so that its sides are vertical. Opposite one of the sides of this plate there is an immovable copper cylinder, that end of which, lying next the copper plate, being highly polished. The temperature of this cylinder may be raised by an electric current passing through a platinum coil surrounding it. The expansion of a cylinder moves the plate, by an amount which is read off from the reflection cast by the mirror.

Trade Notes and Formulæ.

The following recipes and formulæ are published simply as suggestions. Chemicals vary, for which reason it is not always possible to comply with the conditions stated, or for us to guarantee the accuracy of the recipes. A little experimenting, however, will easily enable the interested reader to ascertain just what modifications are necessary to meet his requirements.—Editor of SCIENTIFIC AMERICAN SUPPLEMENT.

Terra-cotta Varnish.—Mastic 2 parts, shellac 20 parts, Venice turpentine 5 parts, spirits of wine, 60 parts.

Cement for Terra.cotta Articles.—Pine rosin, 70 parts, wax 70 parts, hammer-scale 8 parts, drift-sand 8 parts, sulphur 16 parts.

Cement for Ordinary Earthenware.—Equal parts of rosin and wax are melted together and as much pulverized caustic lime added as will leave the mass, at a moderate heat, readily fluid.

Tartri-fuge (anti-boiler scale) 10 parts talcum powder, 10 parts wheat flour, 10 parts bean flour, 20 parts animal fat, 10 parts extract of log-wood, 10 parts soda and 30 parts sulphate of soda.

To Remove Oil Spots from Wall Paper.—Make a paste of pipe clay or fuller's earth and cold water and apply to the spot, without rubbing. Leave it on overnight and brush it off next morning. Repeat the process.

To Prevent Peeling Off of Paste With Wall Paper.—Steep 18 parts of bole, beaten fine, in water, pour off the water, add 1.5 parts of glue, boiled to size, also 2 parts of plaster. The mixture is to be rubbed through a sieve, by means of a paint brush and water added to thin.

Tectolith, a Roofing Material. The foundation is linen or hemp fabric. It should be drawn through a mixture of 10 to 15 parts glue, 5 to 6 parts glycerine, 15 to 20 parts cellulose and 60 to 70 parts of water, pressed out thoroughly and coated on both sides with a thin layer of wood pulp. For the subsequent asphalting, about 5 per cent of infusorial earth should be added to the tar.

To Preserve Ropes, Cordage and Nets.—Allow the ropes or cordage to remain four days in a bath of 2 parts blue vitriol solution, to 100 parts of water, then dry them. The cordage will thereby have taken up a quantity of blue vitriol, which will preserve it from parasites, mold and rot. The copper salts can be fixed by means of tar or soap-water. For the last-named method, a solution of 10 parts of soap to 100 parts of water, should be used.

Tar Varnish for Caulking Ships.—Take 100 parts of pitch, melt it over a gentle fire in large, open kettles, take it off the fire, and add 40 parts of anhydrous coal tar.

Tar Cement.—For drain-pipes, in which the joint sleeves must remain pliant but water proof, use a mixture of 100 parts hot tar, 2 parts sulphur. After this is dissolved, stir in about 300 parts of fine clay powder. Can also be prepared without the sulphur.

To Refine Tallow (according to Castelhaz).—100 parts of raw tallow are stirred into 100 parts of boiling water, then 4 parts of soda, dissolved in 20 parts of water, added and stirred in until the entire fluid assumes a milky appearance; 400 parts of water are then added, and the tallow, which separates at the top on standing, is again treated, in the same manner, with soda solution. Water is again added and the soda treatment repeated a third time, only 2 parts being this time added. Finally, the water added is heated to boiling and the tallow repeatedly washed with clear water, or at first with water containing 1 per cent of hydrochloric acid. The tallow, thus refined, is wholly tasteless and odorless.

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